Not really in the series

DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

OF

THE TERRITORIES.

F. V. HAYDEN,

UNITED STATES GEOLOGIST-IN-CHARGE.

VOLUME VII.

WASHINGTON:
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1878.

LETTER TO THE SECRETARY.

OFFICE OF THE UNITED STATES GEOLOGICAL AND
GEOGRAPHICAL SURVEY OF THE TERRITORIES,
Washington, D. C., January 1, 1878.

SIR: I have the honor to transmit herewith, for your approval and for publication, the Seventh Volume of the Final Reports of the Survey under my charge.

The work consists of a Report on the Tertiary Flora of the West, by Prof. Leo Lesquereux, of Columbus, Ohio, being Part II of "Contributions to the Fossil Flora of the Western Territories"—Part I being "The Cretaceous Flora", by the same distinguished author, whose long-continued studies in palæo-botany have placed the subject upon a firm and enduring basis. Part I formed Vol. VI of this series of Final Reports, and the present Part constitutes Vol. VII.

The circumstances which led to the preparation of this work may be briefly reviewed.

When the geological investigation of the Lignitic formations of the West had reached a certain point, the conclusions derived from such studies were discussed by certain geologists who dissented from the views then expressed respecting the age of these strata. It consequently became desirable, in order to the solution of the questions involved, to elaborate further, and with the greatest care, all available material bearing upon this interesting problem. To this end, I desired Prof. Joseph Leidy, Prof. E. D. Cope, Mr. F. B. Meek, and Prof. Leo Lesquereux, to present in detail all the evidence they could secure in their respective specialties of Extinct Vertebrata, Extinct Invertebrata, and Fossil Flora, bearing on the disputed age of these formations, to decide, if possible, whether the strata in question are Cretaceous or Tertiary. The various reports which these gentlemen have furnished testify with what zeal, ability, and success these instructions have been carried out.

If objection is made to the use of the term "Lignitic" Group, I would say that, in this work, it is restricted to a series of coal-bearing strata lying above the Fox Hills Group, or Upper Cretaceous, and these are embraced in the divisions Laramie and Fort Union Groups. It is well known that there are in various parts of the West, especially along the fortieth parallel and southwestward, very thick beds of coal in the various divisions of the Cretaceous, extending down even into the Upper Jurassic. Had this not been the case, the more general term Lignitic would have been retained by this Survey, in preference to any other.

As far back as 1859 it was my belief, founded on what appeared to be sufficient evidence, that the sequence between the well-characterized Cretaceous strata and those of the Lignitic Group, as defined at that time, was continuous, and that the chasm which was supposed to exist between the Cretaceous and the Tertiary epoch would be found to be bridged over. This belief was not based on strictly palæontological evidence, for no well-marked Cretaceous fossils were then known to pass up into the Lignitic or brackish beds. But the physical conditions under which the sediments of the upper strata of the Fox Hills Group were deposited indicated a gradual change, from deep, quiet marine seas to shallow waters, which became at length brackish and finally entirely fresh waters, during which time the purely marine invertebrate fauna perished, a brackish and purely fresh-water fauna taking its place. This condition of the Lignitic Group covered a vast area in the Northwest, extending far southward, along the eastern slope of the Rocky Mountains, to Denver, Colorado. As we proceed southward and westward from the Missouri River, the brackish beds increase in thickness until along the fortieth parallel they become three thousand feet or more, indicating, so far as can be determined, no break in the sequence from the Fox Hills Group to the purely fresh-water strata of the Wahsatch Group.

Dr. C. A. White, Palæontologist to the Survey under my charge, has made a critical examination of these formations during the past season, and he says that his investigations have fully confirmed the views expressed by me some years ago, and indicated by the palæontological studies of Mr. Meek, that the Fort Union beds of the Upper Missouri River are the equivalent of the Lignitic formation as it exists along the base of the Rocky Mountains in Colorado. He also testifies to the equivalency of the latter with the Bitter Creek series west of the Rocky Mountains. These views of Dr. White are con-

firmed, not by the discovery merely of one or two doubtful species common to the strata of each of these regions, but by an identical Molluscan fauna ranging through the whole series in each of the regions named. This shows that the strata referred to, all belong to one well-marked period of geological time. Dr. White arrives at these conclusions, not merely because there is a similarity of type in the fossils obtained from the various strata of the Laramie Group with those that were before in question, but by reason of the specific identity of many fossils that range from the base of the Laramie Group up into and through the strata that were formerly referred to the base of the Wahsatch. Some of these species were found by Dr. White in the Laramie strata on both sides of the Rocky Mountains, with a vertical range of not less than three thousand feet and a geographical range of more than a thousand miles

The conclusion, therefore, becomes more and more apparent that while the principal groups of the Mesozoic and Cenozoic formations in the West have each peculiar characteristics, and are readily recognized by the geologist, they really form an unbroken series of strata, not separated by sharply defined planes of demarcation, either stratigraphical or palæontological. The facts as we understand them at the present time would seem to warrant this general division, viz.: a marine series, Cretaceous; gradually passing up into a brackish-water series, Laramie; gradually passing up into a purely fresh-water series, Wahsatch. It is also probable that the brackish-water beds on the Upper Missouri must be correlated with the Laramie, and that the Wahsatch Group as now defined and the Fort Union Group are identical as a whole, or in part at least. The plants which are recorded in this volume began their existence at the base of the Laramie Group, and continued through the entire series, brackish and fresh-water. The reason will now become apparent why I have, in my former reports, called the Laramie Group a transition series, or beds of passage, not as a distinctive name, but only as indicating the fact that they seemed to bridge over the chasm between the purely marine Cretaceous and the purely fresh-water Tertiary.

The lack of animal remains in the Lower Lignitic Measures, especially those of Colorado, is remarkable. On the other hand, all the coal-bearing strata above the Cretaceous Fox Hills Group abound in well-preserved vegetable remains. The comparatively few specimens of fossil plants obtained by the Survey in Colorado up to the year 1870 pointed to the conclusions

which are now reached, but the evidence they represented was deemed inconclusive. Prof. Lesquereux was, therefore, desired to take the field under the direction of the Survey, to study the Fossil Flora of these beds at all the more interesting localities, from New Mexico through Colorado into Wyoming and Utah. Some results of his researches, conducted during two seasons, have already been given to the public in the Annual Reports of the Survey, where the many new species discovered were named and briefly characterized. Such description of fossil remains of plants, often represented by mere fragments, was found to be inadequate to the full exposition of the subject which science demands. It became necessary, therefore, to figure these fossil plants with great care, in order that their characters might be fully appreciated, and to compare them closely with those already known from the different geological formations of Europe. By such representation and examination alone, could safe conclusions be drawn respecting their true geological relations.

The carefully drawn plates which illustrate the subject, prepared by Prof. Lesquereux himself, or under his immediate supervision, place the characters of these remains in the clearest light. The greater portion of the text of this volume, forming Part Second, is devoted to the determination, description, and discussion of the several species. The First and the Third parts treat mainly of the geological bearing of the fossil plants and animals upon the main question of the age of the Lignitic formations of the West, and represent the conclusions derived from the study of the remains here figured and described in connection with consideration of the evidence afforded by the fossil animals.

The author states that his final conclusions do not differ materially from those already advanced by myself, and he regards the evidence as conclusive that the Lignitic Group is of Tertiary age. This result is gratifying, not only as settling the question at issue, but as silencing criticism of the value and reliability of the general work accomplished by the Survey under my direction.

Apart from the technical aspects of the scientific problem here solved, the Lignitic formations of the West have an economic importance that cannot easily be overestimated. Their wide extent and the number and thickness of the beds of coal distributed through these strata confer a value not less than that of the true Coal-Measures of the East, from the Mississippi to

Massachusetts. Their importance and practical value are enhanced by their presence in a country otherwise almost destitute of fuel. These Western Coal-Measures render rail communication between opposite sides of the continent not only practicable, but easy; they make possible the settlement of an otherwise scarcely inhabitable country, and are invaluable in the prosecution of the mining and manufacturing industries of the Rocky Mountain region. The plants which afford this valuable combustible material merit close study, no less from an economic than from a purely scientific point of view.

Other scientific deductions than those already presented are derived from such investigations. To the study of the plants of the older Coal-Measures we owe not only our knowledge of the vegetation of the several geological epochs, but also our recognition of the diverse climatic conditions which marked successive periods during the slow formation of the continent. Until recently, the physical influences prevailing during the progressive modification of the earth's surface from the earliest periods to the present time have been considered in this connection only by the European palæobotanists. Europe has seen the appearance of many works upon the fossil plants of all her formations; but these records, however rich and interesting, are incomplete without comparison with those of other continents. Deductions respecting the possible uniformity of the climatic conditions of any one period over the whole hemisphere, or regarding the origin and distribution of plants, and the actual character of vegetable life, remain unreliable and wholly unsatisfactory so long as they rest merely upon local observations. The scientists of Europe, fully aware of this, have regarded the study of the fossil botany of America as of the utmost importance, and have received with evident satisfaction the first contributions to the knowledge of the subject from investigations conducted in North America. A number of memoirs have already appeared upon the Fossil Flora of the true Carboniferous or Coal-Measures of the United States. The publication of Professor Lesquereux's Cretaceous Flora of the Dakota Group, forming Vol. VI of this series of Reports, awakened great interest in the whole subject, and incited fruitful discussions respecting the European formations of the same epoch. The present volume, on the Tertiary Flora, opens a page of no less interest and one still more important—one on which are traced the characters of a

geologic record which too long remained blank, while the spirit of scientific inquiry was moving in other lines of research with such effective energy. The lively and widespread interest manifested by the people of the United States in the progress of science would ensure the favorable reception of a work upon a hitherto unknown subject, even though it did not relate, as this one does, to one of the most practically valuable as well as scientifically remarkable geological formations of the continent.

The study of palæo-botany acquires its highest interest when considered in connection with the plant-life of the present time. Fossil plants are records of the past, engraven on the rocks—the legible documents which enable the student to discern whence and how the Flora of to-day has acquired its character. The study of recent vegetation is linked with that of the long past as indissolubly as are the plants themselves related by descent with modification from preëxisting forms; and its rational interpretation is possible only when the subject is viewed in the reflected light of geological succession.

But the study of Fossil Floras may be brought to bear upon questions of still greater magnitude and importance, even those of the origination of continental land-areas as at present existing, and of their connection or separation at certain periods of geologic time. To recognize, for example, that the present American Flora includes types traceable back to the oldest geologic formations, and that the continent has preserved certain peculiar types, not found in Europe or elsewhere, through all the mutations of its surface-features, would authorize the deduction that these land-areas were separated for a corresponding length of time. Such studies, again, bear upon the problem, whether, as some believe, the North American Flora was derived by migration across intermediate land, either from Europe or Asia, or whether, as others maintain, the Flora was indigenous and consequently peculiar. Such considerations bring us face to face with one of the greatest and gravest problems that the human intellect may aspire to solve, namely, the origin and development of species.

The value which attaches to the study of Fossil Floras as furnishing data for general geological purposes has been often disputed. It is well understood that palæontological or palæo-botanical material is more or less valuable and reliable in proportion to the abundance and state of preservation of

specimens. In general terms, it may be said, that, in the determination of marine formations, the remains of fossil plants have little value in comparison with those afforded by fossil animals. But the conclusion of this volume, it is hoped, shows that the study of fossil plants gives no less reliable data than those afforded by animal remains in the investigation of land formations.

During the whole course of his researches upon the Mesozoic and Cenozoic Floras of the West, the author has been in constant communication with Heer, Schimper, Saporta, and other eminent palæo-botanists of Europe, who have commented upon the progress of his labors in the most favorable terms, and have unequivocably confirmed his conclusions. Whatever difference of opinion may continue respecting the age of the formation from which the plants treated in this volume have been derived, the memoir will ever remain an eloquent witness to the learning and ability of its illustrious author, and a monument to the science he has for years cultivated with the most gratifying success. If he may not be said to have created palæo-botany in America, he has been foremost in fostering it, and has brought it to the point of advancement that is matched only by the standard of excellence that the most eminent of his European compeers have attained.

F. V. HAYDEN,
United States Geologist.

Hon. Carl Schurz,
Secretary of the Interior, Washington, D. C.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

CONTRIBUTIONS

TO

THE FOSSIL FLORA

OF THE

WESTERN TERRITORIES.

PART II.

THE TERTIARY FLORA.

By LEO LESQUEREUX.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1878.

TABLE OF CONTENTS.

PART I.

PART II.

PART III.

LIST OF ERRATA.

In indicating the number of lines, I do not count the heading of the pages.

Page 25, line 7 from top, read "*Ostrea*" for "*Ostreo*".
Page 41, line 5 from bottom, read "245" for "244".
Page 42, line 7 from top, read "373" for "273".
Page 47, line 12 from top, erase "stem", which is repeated.
Page 47, line 10 from bottom, read "*laciniæ*" for "*locinœi*".
Page 53, line 9 from bottom, add "Ung. in" before "Heer".
Page 67, line 13 from bottom, read "cellular" for "medullar"
Page 74, line 15 from bottom, read "fig. 2" for "fig. 6".
Page 86, line 8 from top, read "103" for "113".
Page 93, line 16 from top, add "*c*" after "fig. 45".
Page 115, line 13 from bottom, read "Plate IX" for "IV".
Page 118, line 14 from bottom, read "Plate XXXVIII" for "XVIII".
Page 124, line 15 from bottom, read "brachidodrome" for "brachiodrome".
Page 133, line 17 from bottom, the quotation "Lesqx.", etc., goes above, after "p. 545. *Myrica Ludwigii*".
Page 134, line 9 from bottom, read "412" for "413".
Page 139, line 16 from top, read "29" for "30".
Page 151, line 14 from top, read "378" for "373".
Page 167, line 3 from top, add "Pl. XIX" after "p. 25".
Page 171, line 15 from bottom, insert a comma in place of "that".
Page 178, line 12 from bottom, read "fig. 14" for "15 *a*".
Page 183, line 17 from top, read "*Oeynhausiana*" for "*Œninghausiana*".
Page 184, line 19 from top, read "*Oeynhausiana*" for "*Œninghausiana*".
Page 203, line 17 from bottom, add "II" after "Palæont".
Page 216, line 13 from top, read "Plate XXXVI" for "XXVI".
Page 216, line 3 from bottom, read "camptodrome" for "brachiodrome".
Page 219, line 7 from bottom, read "1873" for "1874".
Page 220, line 8 from bottom, read "85" for "35".
Page 220, line 7 from bottom, read "29" for "294".
Page 234, line 19 from bottom, read "shallow" for "hollow".
Page 277, line 4 from top, add "from" after "dentate".
Page 284, line 4 from top, read "whose" for "its".
Page 286, line 9 from top, erase "Supplement, p. 8".
Page 298, line 9 from bottom, read "Pl. LXIII, fig. 8" for "fig. 5".
Page 318, line 4 from top, read "*Eriocaulon*" for "*Eriocolon*".

LETTER TO THE GEOLOGIST-IN-CHARGE.

COLUMBUS, OHIO, *June* 18, 1877.

DEAR SIR: I send you herewith my report on the Tertiary Flora of the Territories.

The work has three essential divisions.

In the first, the general outlines of the geology of the countries wherefrom the specimens of plants have been obtained are briefly exposed. This part is rather yours than my own. It could not be omitted, however, in this volume; for it is advisable, for the understanding of the characters of the floras, to have for reference an exposé of the geographical and stratigraphical distribution of the groups from which the specimens are derived. The quotations on the subject are carefully credited to the original authors.

The second part is the description of the species of fossil plants.

The third reviews the evidence afforded by the fossil flora to the age and the relation of the different groups of the Lignitic formations. The conclusions derived from this review may not be generally admitted; they are, however, confirmed by the careful comparison of the characters of the vegetable remains. This part is prefaced by a few remarks upon the progress of the work from the beginning of my connection with your Survey. I have there mentioned the names of all those who have contributed to the Flora by researches and communications of specimens. This mention is rightly due to all, but especially to some friends who have worked hard and given much time, without any remuneration, to procuring materials often of great value to American palæontology. You will certainly find that they are all entitled to a copy of the Flora, as they are also here to the expression of my most sincere thanks.

This Flora of the North American Lignitic is like a supplement to that of the Cretaceous Dakota Group. Both together constitute a historical record not less interesting to Botany than to Geology; for, beside the evi-

dence afforded on the relation of the groups of the formations, they expose, as in a written book, documents illustrative of the origin and the successive development of some of the predominant and more interesting types of the present vegetation of this country.

Allow me here to give expression of my gratitude for the assistance which you have given to my work and the constant interest by which you have greatly encouraged it.

Very truly and respectfully, yours,

L. LESQUEREUX.

Dr. F. V. HAYDEN,

United States Geologist, Washington, D. C.

PART I.

INTRODUCTION.

THE LIGNITIC FORMATIONS OF NORTH AMERICA.

§ 1.—*Areal distribution.*

The country west of the Missouri, and to the base of the Rocky Mountains, is for nearly six hundred miles—as from Omaha to Cheyenne, or from Kansas City to Denver—a vast plain, with a gradual slope, unappreciable to the eyes, and without any of those land irregularities which generally, breaking the stratification by upheavals or denudations, expose to view the rocks composing the crust of the land surface. The ascending grade from the Missouri River toward the mountains does not average more than ten feet per mile, and as the Cretaceous strata exposed below Omaha above the Permian Measures, are nearly horizontal, they pass, of course, toward the west under the different stages of the Tertiary or under more recent deposits. The great uniformity of the plains and the absence of exposed rocks prevent the distinct tracing of the line of demarkation between the Cretaceous and the Tertiary. As far as it is known in the States of Iowa, Kansas, and Nebraska, the average width of the belt occupied by the Dakota group, which is in that country the lowest member of this formation, is from sixty to one hundred miles.* Over this appear the Upper Cretaceous groups, which, where they have been observed along the Missouri River, have a thickness of more than two thousand feet, or, for the whole Cretaceous formation, two thousand five hundred feet. As from Omaha to Cheyenne, which

* Report of the United States Geological Survey of the Territories, by Dr. F. V. Hayden, vol. vi, Cretaceous Flora, p. 12.

is five thousand feet higher, the distance is five hundred miles, admitting horizontality of the measures and uniformity of the grade, the belt of the Cretaceous should occupy about half the width of the plain between the Missouri River and the base of the mountains. This estimate is, however, too high; for, along the Missouri River, Dr. Hayden fixes the eastern limits of the Cretaceous, or the appearance of the Tertiary over them, at Fort Benton;* and considering the Lignitic area as marked in his geological map of the Yellowstone and Missouri Rivers,† that of the Cretaceous would, from east to west, be about one-third the width of that of the Tertiary.

The first record we have of the area of the Lignitic, or at least of its wide extent along the Missouri and the Yellowstone Rivers, is obtained from the narration of the voyage of Lewis and Clarke in 1804. The following passage is copied from R. C. Taylor's Statistics of Coal, p. 174:—

"The coal, or lignitic, was first observed twenty miles above the Mandan village. The bluffs on each side of the river are upward of one hundred feet high, composed of sand and clay, with many horizontal strata of carbonated wood, resembling pit-coal, from one to five feet each in thickness, and occurring at various elevations above the river. At fifty miles above the village, similar coal seams were noted; but here they were observed to be on fire, emitting a quantity of smoke and a strong sulphurous smell. Further on, the same sulphurous coal continued for eighty miles more; strata of coal, frequently in a state of combustion, appearing in all the exposed faces of the bluffs. The quality of the coal improved as the party advanced, near the mouth of the White River, eighty-five miles farther, affording a hot and lasting fire, but emitting very little smoke or flame. Thence forty-seven miles, to the Yellowstone River, and at a bluff eight miles up that stream, were several strata of coal. For fifty miles above the junction of the Yellowstone and the Missouri, there were greater appearances of coal than had yet been seen, the seams being in some places six feet thick; and there were also strata of burnt earth, which were always on the same level with those of coal. The explorers had thus far traced this lignite formation along the banks of the Missouri for a distance of three hundred and thirty miles. The horizontal formation of clay, loam, and sand, with fragments of coal in the drift of the river, extended three hundred miles more, to Muscleshell River,

* Dr. F. V. Hayden, Annual Report, 1869, p. 48.

† United States War Department Map of the Yellowstone and Missouri Rivers, explored by Capt. W. F. Raynolds and Lieut. H. E. Maynadier, 1859-60.

or six hundred and twenty miles from Mandan Village. Even above this point, washed coal continually appeared on the shores of the river, and at Elk Rapids, eight hundred miles from Fort Mandan, the high bordering bluffs were still composed of horizontal beds of clay, brown and white sand, soft, yellowish-white sandstone, hard, dark-brown freestone, and large, round, or kidney-shaped nodules of clay iron ore. Coal, or carbonated wood, similar to that previously observed, was also seen, and was accompanied with burnt earth, probably the result of the spontaneous combustion of the coal, as was noticed for hundreds of miles below. After reaching the Grand Fork of the Missouri, and ascending two or three days' journey up Maria's River northward, it was remarked that precisely the same geological character and coal strata prevailed for more than sixty miles. So far, therefore, the exploring party had been traveling through or over a ligneous deposit of singularly uniform character for no less than nine hundred and eighty miles, following the windings of the river. Pursuing the South Fork toward the Great Falls of the Missouri, coal was still observed in bluffs of dark and yellow clay at a distance of two thousand four hundred and fifty-four miles up that mighty river, and it was not until near the base of the Rocky Mountains, and after one thousand miles of traveling across it, that this great region of coal-beds and lignites was passed."

"On the return, Captain Clarke descended the Yellowstone from about north latitude 45° to its mouth, 48° 20′, and everywhere found the same series of coal and variously colored clays and soft sandstones as was traversed in ascending the Missouri. Below the Big Horn is a large stream falling in from the south, whose Indian name implies the Coal Creek, from the great quantity of this mineral upon its border. The same coal series continued to the confluence of the Missouri, exhibiting uninterruptedly for seven hundred miles, in addition to the thousand previously traversed, the vast persistence of this formation. The enormous area of similar strata is further shown by the decoloration of all the tributaries that enter the Missouri from both the south and the north, from the forty-second to the forty-ninth degree of north latitude."

It is from the records of those celebrated explorers especially, also from those of Audubon and Harris, Sublette, Frémont, Emory, etc., for the United States, from the explorations in British America by Dr. Richardson, Drummond, and Captain Franklin, that Taylor obtained the data for the delineation

of the area of the Lignitic in the map of his Statistics of Coal, 1848.* As an introduction to it, he remarks (p. 23) on that enormous range of brown coal, apparently of the Tertiary period, which follows the eastern flank of the Rocky Mountains, from near Mexico even to the Polar Sea:—"Nature", he says, "has indeed worked on a truly gigantic scale. We see here a deposit of brown coal so extensive that the magnitude of its proportions is far from being defined; yet enough is known to show that it exceeds in longitudinal range and breadth all others of the present surface of our planet. So far seems to be established, that, allowing liberally for interruptions in continuity, supposing that any such exist, it occupies thirty-five degrees of latitude, or near two thousand five hundred miles, following the oblique range, and has a maximum breadth on north latitude 48° of four hundred miles; the whole area, as near as we can venture to compute, being two hundred and fifty thousand square miles, or one hundred and sixty millions of acres, more than twice the size of Great Britain. Compared with this, the largest coal-fields in the world are absolutely small."

Audubon and Harris ascended the Missouri to the mouth of the Yellowstone River. In the account of their voyage, they give, on the Tertiary strata of the country, details in accordance with those recorded by Lewis and Clarke.† The whole series of strata, for many hundred miles prior to reaching this formation, is described as perfectly horizontal; the upper part of each bed or rock being successively intersected by the angle of descent to the river. The Tertiary group is indicated by the remarkable strata which form the picturesque hills noticed by travelers, and called *Mauvaises-Terres* by the trappers and voyageurs. Mr. Harris counted in one place eight seams of coal between the river bank and the top of the bluff, varying from six inches to four feet in thickness. This coal, he observes, is very light, and ignites with difficulty, emitting a very unpleasant odor while burning. Fossilized wood is very abundant, occasionally much flattened by the pressure of overlying strata. Mr. Bell was the only one of the party who had an opportunity of witnessing the burning of the cliffs about thirty miles above the Yellowstone, on the northern bank of the Missouri, and all agree in attributing their burning to the spontaneous combustion of the coal. Mr. Harris states that the coal-seams commence in the upper part of Nicollet's great Cretaceous clay bed,

* Chart showing the position of the coal-fields on the surface of the globe, by Richard Taylor.

† Proceedings of the Academy of Natural Sciences of Philadelphia, May, 1845.

and further, that there occurs in the same formation a substance like petroleum in color and consistence, but without odor; that from the specimens brought home by the last-named traveler from the vicinity of Fort Union, near the confluence of the Yellowstone and Missouri Rivers, we derive incontestable proofs of a fresh-water formation. Among other strata exposed in a cliff near the fort are thin beds of clay and argillaceous rock, both containing three or four species of fresh-water univalve shells. There is besides a rock twenty or thirty feet thick, which also contains proofs of fresh-water origin in bivalve shells, leaves of deciduous trees, and bones apparently of mammiferous animals.

Details in accordance with those given above are reported from the belt of the Lignitic surveyed north of the limit of the United States and British America. They extend to Vancouver, even to the Arctic land of Disco, Greenland, and southward along the Pacific slope to the southern extremity of the continent. They are, however, still less precise, and evidently Mr. Taylor refers to the Tertiary coal deposits of different geological ages. Hence, we have as yet nothing definite in regard to those mentioned coal strata. Even we may say that scarcely anything positive was known of the great North American Lignitic when Dr. F. V. Hayden undertook the work of exploration and began his researches, in 1854. It is therefore from the numerous publications of reports and memoirs of the celebrated geologist that I have to take most of the reliable facts exposed in this introduction.

I cannot enter into the examination of Dr. Hayden's researches without remarking on the accuracy of the data which he has exposed in his numerous Reports and Memoirs on the Geology of the Western Territories. Beginning in Kansas and Nebraska, he has followed the explorations foot by foot, so to say, not omitting a single fact worth the attention of the geologist. Collecting specimens of ore, of minerals, of animals, of plants, he has by and by traced the outlines of the present and ancient history of these Western Territories; and calling to his assistance all the specialists who might render his work more complete, he has filled the pages of a truly invaluable record. For now, the natural history of those western regions, mostly unknown a few years ago, is exposed as distinctly and precisely as may be that of any of the oldest States of the Union. The agricultural and mineral resources, the geographical and stratigraphical distribution, the fauna and flora of the present epoch, those of the former geological periods, even the phys-

ical circumstances influencing the character of the countries surveyed, all have been considered and studied by Hayden. His researches show the constant vigilance and circumspection of a master attending to the performance of a great work, the building of a monument whose plan has been prepared by serious scientific studies. I speak here by experience, for in the part assigned to me I had to follow, so to say, the footsteps of the master, and found that even the matters of the least importance had been already recorded by him, and outside of my specialty, the study of the paleobotany of the Cretaceous and the Lignitic, I could scarcely find anything worth mentioning as new.

The first explorations of Dr. Hayden over the western coal regions, to which the name of Great Lignitic is generally and appropriately given, were extended first up the Missouri River from the first appearance of the Tertiary strata near Fort Clarke to the mouth of the Yellowstone, and thence up that river to a point near the mouth of the Big Horn for a distance of about six hundred miles. He considers that the area of the Lignitic formations cannot be, on the Upper Missouri, less than one hundred thousand square miles, without taking into account the belt which extends far north across the boundary of the United States into the British Possessions.*

On the geological map of the Yellowstone and the Missouri Rivers, prepared for the explorations of Capt. W. Raynolds and Lieut. H. E. Maynadier for 1859–60, the part colored as Tertiary Lignitic by Dr. Hayden, who had charge of the geological researches, indicates a wider area, not less than one hundred and twenty-five thousand square miles, and this only from the boundary of the British Provinces to the Black Hills. Between these and the Rocky Mountains, south to the Nebraska River, the Tertiary belt is still continued over a surface of about sixteen to seventeen thousand square miles. Farther south we have not as yet any map exposing the distribution of the Tertiary. Prof. Hayden, considering this part of the area occupied by the Lignitic, says:†—"We may trace it southward in a broad continuous belt across the Yellowstone River, between the Black Hills and the Big Horn Mountains, until it is overlapped by the White River group about sixty miles north of Fort Laramie. If we continue southward along the base of the Laramie Range, we find that the Lignitic group reappears about ten miles south of the Union Pacific Railroad; that where the White River group and the Lignitic

* Report of the United States Geological and Geographical Survey of the Territories, 1874, p. 20.

† Loc. cit., p. 26.

come in contact, the former is superimposed to the latter; and that really the White River group formed a vast basin subsequent to the existence of the great lake on which the Lignitic sediments were deposited." He adds:— "We find also, by examining the White River group along the base of the mountains, that the Laramie Range formed a barrier that prevented it from extending into the Laramie Plains; but the evidence is clear that at the time of the existence of the great Lignitic lake or sea, this barrier did not prevent the water communication with the Laramie Plains. Indeed, the evidence seems quite clear that, with the exception perhaps of some isolated peaks rising above the waters, there was no mountain barrier where we have now the Laramie Range. Therefore, with the exception of the Bear River and Coalville group, we may connect the coal-bearing beds of the Laramie Plains and Colorado with the vast group in the Northwest."

The southern basin, generally named the Colorado Basin, is followed, nearly without interruption, from a few miles south of Cheyenne to New Mexico. It is continuous to the South Platte below Denver, where it is covered by a ridge of hills, the Monument Creek group, and then reappears near Colorado City. On the Arkansas River, near Cañon City, outlayers of the Lignitic have been left upon the Cretaceous, which by denudation is exposed over nearly the whole valley; and south of the Arkansas, or from the Spanish Peak the belt becomes continuous again to the Raton Mountains, in New Mexico, with outlayers or isolated patches appearing as far south as Albuquerque.

The southern Lignitic covers, therefore, an extensive area. It cannot be estimated, however, for the reason that it is cut by more recent deposits at some places, as south of Denver, and by erosions along the Arkansas River, and especially because its width from the mountains to the east is unknown. The upheaval of the mountains has exposed the edges of the Tertiary strata with those of the underlying formations, throwing them up into a series of hogbacks, which pass very abruptly from an inclined, even vertical, position, in the proximity of the mountains, to a horizontal direction toward the plains. All along the mountains, the Lignitic is at the upper stage, and therefore it is covered merely in passing to the plains by the more recent deposits of the surface. But how far it extends, or it is accessible for coal, has not yet been ascertained. Shafts have been sunk east of Denver about ten miles, and thick beds of coal or lignite have been reached at a moderate depth. Other

shafts, near Platteville, north of Denver, have also reached coal quite near the surface, showing that the belt of the Lignitic extends, locally at least, to a great distance eastward from the base of the mountains.

§ 2.—*Stratigraphy of the Lignitic and its capacity for combustible mineral.*

On this subject we have documents more precise than for the former, though they are not complete as yet; for the amount, thickness, and chemical value of the coal or Lignitic beds is far from being exactly known, or even far from being possibly estimated. Where the Lignitic has been recognized from its base, it has been seen overlying the Upper Cretaceous strata, whose section is exposed in the Annual Report of Dr. Hayden for 1870, p. 87. The two upper groups, the Fort Pierre group, No. 4, and the Fox Hill bed, No. 5, have generally an abundance of invertebrate fossil remains, and a peculiar lithological composition, which makes them easily recognizable. In the North Basin, or the Fort Union group, the superposition of the Lignitic to the Cretaceous is not marked by any definite line of demarkation. Indeed, this line is seen nowhere, neither in an abrupt change of the compounds, nor in an unconformable stratification, nor in the character of the faunas. On this subject, Dr. Hayden remarks:*—"When we bear in mind the fact that where the Lignitic has been seen in contact with the last Cretaceous beds, the two have been found to be conformable, however great the upheavals and the distortions may be, while at the junction there seems to be a complete mingling of sediments, one is strongly impressed with the probability that no important member of either system is wanting between them." And at another page:†—"That the passage from the brackish- to the fresh-water beds of the Tertiary is not marked by any material alterations in the nature of the sediments, nor have we, as far as it is known, any reason for believing that any climatic or other important physical changes, beyond the slow rising of the land and the consequent recession of the salt and brackish water, took place during the deposition of the whole of the oldest members of the Tertiary."

In his Geological Report on the Exploration of the Yellowstone and Missouri Rivers, 1859–60, Dr. Hayden remarks upon the Lignitic of the Yellowstone River (p. 58):—"Passing up the valley of the Yellowstone, we see the gray sandstone Tertiary, which we have observed to cover the Cretaceous nearly to the foot of the bluffs. The junction of these formations is quite

* Annual Report, 1874, p. 24. † Same Report, p. 22.

well marked on both sides of the river. For a considerable distance both above and below Fort Sarpy, a bed of sandstone forms nearly vertical bluffs on both sides of the river, which I find it difficult to locate. Cretaceous Nos. 4 and 5, composed of yellowish-brown indurated clay, with concretions containing *Baculites ovatus*, *Rostellaria*, etc , in great abundance, occur, passing into a dark gray coarse-grained sandstone, containing also *Baculites ovatus*, *Avicula*, like *A. Nebrascensis*, and an *Ostrea*, new species. This also passes into a sandstone having a most ragged front, from atmospheric agencies and the difference in the consistency of the material composing the bed. It is in the main a coarse-grained, friable, ferruginous yellow sandstone, but containing vast numbers of concretions; some a reddish-yellow arenaceous limestone, others sandstone; some nearly compact, with laminæ; others divided into thin layers, the harder portions projecting out beyond the friable ones. The harder layers lie in the vertical cut, usually from five to thirty feet long.

"The layers are quite irregular in their horizontal fracture, the whole bed exhibiting indications of having been deposited in moving waters. May it not be the transition bed from the Cretaceous to the Tertiary epoch, the foreshadowing of the Tertiary period?"

In reviewing the whole of the Reports of Dr. F. V. Hayden and of his assistants, we find similar descriptions of the same great sandstone forming the base of the Lignitic Measures. My own section of the sandstone overlying the Cretaceous No. 4 on the Purgatory River, near Trinidad, New Mexico, is, as will be seen, like a more detailed repetition of Dr. Hayden's description of the so-called transition sandstone, and also the other sections of the Lignitic productive measures overlying it expose the general distribution of the Lignitic beds, as indicated by the numerous sections given in the same Report of Dr. Hayden of the Upper Missouri, or North Lignitic group, thus recording the same characters of the measures at both extremes of the North American basin.

As an example of the distribution of the Upper Lignitic, I copy the section of the Pumpkin Butte, between the Black Hills and the Big Horn Mountains, in the southern part of the North or Missouri Lignitic. It is in descending order:*—

	Feet.
1. Light yellow friable sandstone, with numerous rusty seams	75

The compact bed of sandstone caps all the hills, and gives them the flat, table-like surface which they present at a distance.

* Report, 1859-60, p. 73.

2. Alternate beds of lignite, gray and yellow ferruginous friable sandstone, with bluish ash-colored, gray and yellow reddish tinged marls and clays, with three seams, of one or two inches thick, of impure lignite	125
3. Indurated yellow and ash-colored marls, with three small seams of impure lignite, with one thin layer, six inches, of reddish-yellow sandstone	60
4. Thin veins of eight inches of impure lignite, with numerous fine crystals of selenite and masses of petrified wood.	
5. Variegated clays and marls, with much sulphuret of iron and two small seams of lignite	33
6. Impure chocolate lignite, with clay underneath, and large quantities of selenitic crystals	2
7. Light gray and bluish ash-colored indurated sandstone, laminated clay and marls, with one or two seams of chocolate-colored impure lignites	148

This section, recording four hundred and twenty-eight feet of strata of the upper part of the Lignitic Measures, is like the part overlying the productive measures of Cañon City coal, as given in my report (1872, p. 324). Here we have a capping of hard sandstone, two hundred feet, over scarcely productive measures, formed by an alternation of beds of soft clay or soapstone, with an abundance of silicified wood, thin seams of lignite (the outcrop of one near the top indicating two feet), beds of clay hardened and blackened by carbonaceous matter, etc. Most of the sections of the great Lignitic basin of the north are more generally or mostly of the upper strata. The thickness of its lower coal-measures is, however, locally very great; for Prof. Hayden, in his Report (1874, p. 21), says that the lower brackish-water beds are more than two hundred feet in thickness, and that those that are purely fresh-water must reach an aggregate thickness of three thousand to five thousand feet, with from twenty to thirty beds or seams of lignite (not including thin seams of an inch or two, which are very numerous). The lignite beds average from six inches to ten feet in thickness.

Though the distribution of the strata of the southern basin has been distinctly and specially exposed in numerous reports of Dr. Hayden and his assistants, as I have myself carefully surveyed a large part of it—that extend-

ing along the base of the mountains from the Raton to Cheyenne, and thence along the Union Pacific Railroad to Evanston—I shall especially quote from these observations given in detail in Dr. Hayden's Annual Report for 1872.

Perhaps one of the finest exposures of the Lower Lignitic Measures in regard to its relation to the Cretaceous is that of the base of the Raton Mountains, a few miles south of Trinidad, and that of the bluffs on the Purgatory River, opposite this last place, and mentioned above. The base of the Raton is composed of a series of heavy, mostly whitish, sandstone, which is conformably superposed to the black shales of the Cretaceous No. 4. This sandstone is also conformably overlaid by the productive Lignitic. The whole section, being fully exposed from top to base, is as follows:*—

LIGNITIC.

	Ft.	In.
1. Sandstone and shale covered with pines	60	0
2. Soft shale alternating with soft clay (soapstone)	35	0
3. Outcrop of lignite, indifferent	2	0
4. Soft shale and fire-clay	26	0
5. Lignite outcrop, thin	1	0
6. Hard gray shale with fossil plants at base†	30	0
7. Shaly hard sandstone in bank	6	0
8. Soapstone shale	2	0
9. Lignite outcrop, good	2	0
10. Fire-clay and shale	36	0
11. Lignite bed, exposed	2	6
12. Fire-clay	6	0
13. Soft shale	30	0
14. Lignite, opened	4	0
15. Fire-clay	8	0
16. Ferruginous and shaly sandstone, covered	50	0
	300	6

SANDSTONE.

17. Brown-reddish shaly sandstone, with *débris* of land vegetables	37	0
18. Yellow shaly sandstone full of Fucoids	5	6

* Annual Report, 1872, p. 319.

† At a short distance, the shale passes to sandstone, No. 7.

19. Ferruginous sandstone, barren	11	0
20. White compact sandstone, in bank, and barren	28	0
21. Hard white sandstone, in bank, with Fucoids	10	0
22. Soft white sandstone, with Fucoids	32	0
23. Very hard block sandstone, barren	19	6
24. Ferruginous sandy shale, with Fucoids	6	6
25. White sandstone, barren	5	6
26. Ferruginous sandy shale, with Fucoids	8	0
27. Red shaly sandstone, with great abundance of Fucoids	3	0
28. Hard white sandstone, in bank, with some Fucoids	12	0
	178	0

Between the last stratum, No. 27, and the Cretaceous black shale, no muddy or brackish beds are seen. The transition is remarkably clear, but, indeed, not more marked than it is between some beds of the Lignitic. The characters of the lower group, one hundred and seventy-eight feet, from No. 17 to 28, are clearly described after the section, as follows:—

1. Its general color is whitish-gray; so white, indeed, sometimes, that the lower strata, seen from a distance, appear like banks of limestone.

2. Though generally hard, it weathers by exfoliation under atmospheric influences, and its banks are thus molded in round undulations; and as it is locally hardened by ferruginous infiltrations, it is often, too, concretionary or grooved in cavities, so diversified in size and forms that sometimes the face of the cliffs shows like the details of complicated architecture.

3. It is entirely barren of remains of animals.

4. On the contrary, from the lowest stratum to its upper part, it abounds in well-preserved remains of marine plants or Fucoids, which in some localities are seen even in the sandstone over lignite beds.

5. In its upper part, the sandstone or the shales of this group are mixed with broken *débris* of land vegetation, with which also Fucoidal remains are found more and more abundant in descending.

The disposition of the strata and their compounds is about the same on the other side of Purgatory River, opposite Trinidad, where the section is from top downward: *—

	Feet.
1. Hard, ferruginous, shaly sandstone, with few remains of Fucoids, but abundance of *débris* of land plants	25

* Annual Report, 1872, p. 320.

2.	Hard, whitish sandstone full of Fucoids	57
3.	Shaly sandstone, with abundance of Fucoids	50
4.	Soft, laminated, ferruginous, sandy clay, with Fucoids	11
5.	Ferruginous shale, with Fucoids	4
6.	White block sandstone, barren	5
7.	White sandstone, with Fucoids	22
8.	Ferruginous shaly sandstone, with Fucoids	33
9.	Black shale No. 4, Cretaceous	147
10.	Covered space, sandstone and shale, to bed of river	153

In both these sections, the remains of marine plants are remarked in most of the sandstone strata and their intermediate clay beds, and as abundant at the base as near the upper part; and, in this last section, they are seen mixed with fragments of land plants, even to the top of the sandstone, cut like a tower at the point of the highest hill facing Trinidad.

In passing from the black shale of the Cretaceous No. 4 to this group of sandstone beds overlying it, the difference in the characters is striking, not only in considering their compounds, but in the class of fossil remains which they contain; the traces of deep marine life predominating in the black shale, while here they have totally disappeared. The absence of the Upper Cretaceous formation No. 5 might be taken into account for explaining this difference; it is not the case, however, for, as seen above, the Upper Cretaceous sandstone beds are as definitely characterized by their fossil remains as a deep marine formation as the second group No. 4 Now, at the Raton, in the sandstone above No. 4, marine life marks its activity only by the abundant remains of Fucoids, indicating by their growth a comparatively shallow water. They attest, therefore, a slow upheaval of the bottom of the sea, in which they appear to have lived, for their stems penetrate the sandstone in every direction. And this indication is still more manifest in the great abundance of *débris* of land plants, which, apparently ground by the waves, seem to have been thrown upon the shore and mixed in the sand with Fucoidal remains. This slow upheaval and its result in the formation of a new land are read as in a book in the fossil remains of this group of sandstone, and every observer should forcibly admit that these memorials of old expose the beginning of a new era, or of what we call a new formation.

It has been seen already that Dr. Hayden has everywhere remarked the same distribution, the same conformability of stratification, the same charac-

ters of the lower sandstone, as well in the northern area of the Lignite as in the southern, and has come to the same conclusion expressed here, that it exposes a gradual change or transition, by the slow upheaval of the land, merely a passage from a marine Cretaceous formation to a Tertiary land formation.

In the report above quoted, sections are given of the distribution of the Lignite at Cañon City near Pueblo, Gehring's Coal near Colorado Springs, Golden, etc., which represent the same general distribution of the strata, with mere local modifications, which do not affect in any way the general characters of the group. I can give only a few of the most important sections, especially those which give a satisfactory representation of the capacity of the measures for combustible mineral.

At Golden, seventeen miles west of Denver, the Tertiary Measures, thrown up by the upheaval of the mountains against a basaltic ridge parallel to their base, have been forced up in a vertical position, and thus, from this place to Coal Creek, the Lignitic beds are exposed and worked from their edges, their thickness varying from four to fourteen feet.

Further north, in the Boulder Valley, the measures come to their normal position, dipping in various degrees from the mountains toward the plains, and at Marshall a fine exposition of the Lignitic is presented, as seen in the following section. It is copied from Dr. Hayden's Report, 1869, p. 129, and is scarcely different from that published before, from the same locality, by Dr. John L. Le Conte, and also from that which I received later from the proprietor of the coal:—

48. Drab clay, with iron ore along the top of the ridge.
47. Sandstone.
46. Drab clay and iron ore.
45. Coal (No. 11), no development.
44. Drab clay.
43. Sandstone 15 to 20 feet.
42. Drab clay and iron ore.
41. Coal (No. 10), no development.
40. Yellowish-drab clay, 4 feet.
39. Sandstone, 20 feet.
38. Drab clay, full of the finest quality of iron ore, 15 feet.
37. Thin layer of sandstone.

36. Coal (No. 9), nearly vertical where it has been worked, 12 feet.
35. Arenaceous clay, 2 feet.
34. Drab clay, 3 feet.
33. Sandstone, 5 feet; then a heavy seam of iron ore; then 3 feet of drab clay; then 5 feet of sandstone.
32. Coal (No. 8), 4 feet.
31. Drab clay.
30. Sandstone, 25 to 40 feet.
29. Drab clay, 6 feet.
28. Coal (No. 7), 6 feet.
27. Drab clay, 5 feet.

Dip 37°.
26. Sandstone, with a seam of clay 12 to 18 inches intercalated, 25 feet.
25. Drab clay, 4 feet.
24. Coal (No. 6), in two seams, 4½ feet.
23. Drab clay, 3 to 4 feet.

22. Yellowish, fine-grained sandstone, in thin loose layers, with plants, 5 to 10 feet.

Dip 8°. 15 feet.
21. Drab clay; excellent iron ore.
20. Coal (No. 5), 7 feet.
19. Drab clay.

18. Sandstone, dip 11°. This sandstone has a reddish tinge, and is less massive than No. 14.

20 feet, obscure.
17. Drab clay.
16. Coal (No. 4).
15. Drab clay.

14. Sandstone, massive, 60 feet.
13. Drab clay.
12. Sandstone.
11. Drab clay.
10. Coal (No. 3).
9. Drab clay.
8. Sandstone, 25 feet.
7. Drab clay.
6. Coal (No. 2), 8 feet.
5. Drab clay.
4. Sandstone, about 25 feet.

3. Drab fire-clay, 4 feet.
2. Coal (No. 1), 11 to 14 feet.
1. Sandstone.

This section shows eleven beds of coal, some of which are worked, on a thickness of six to fourteen feet; this in about four hundred and fifty feet of measures. An analogous distribution is recorded by other sections in the Boulder Valley and northward to ten miles south of Cheyenne.

Passing westward from Cheyenne, along the Union Pacific Railroad, the Lignitic measures over the Laramie Plains are covered with more recent deposits. The Cretaceous reappear in the valley of Rock Creek, and from Medicine Bow to Carbon the Lignitic is exposed again. At this last locality we have a section of the mines through one hundred feet of measures, exposing three beds of good coal, which have been actively worked since the construction of the railroad. The section at the shaft is, in descending,—

	Feet.
Shale, clay, and sandstone at top	35
Ferruginous clay, with a profusion of dicotyledonous leaves	3
Clay shales and sandstone, with plants at top	18
Coal (main)	9
Fire-clay and shale, with dicotyledonous plants	20
Coal	4
Fire-clay and shale	8
Coal	4

From Carbon to Black Buttes, geological disturbances bring to the surface older formations in the Rawlins's Basin, but the Tertiary soon reappears ten miles farther west, in entering the so-called Bitter Creek series, near Separation, where a bed of coal, reported eleven feet, has been exposed; farther, at Creston, where another coal-seam, four feet, has been passed by a boring eighty-three feet from the surface; then at Black Buttes Station, where two beds of coal, one four and the other eight feet, are exposed and worked. In following the railroad passing along the anticlinal ridge whose axis is near Salt Wells, to Rock Springs, coal strata are still exposed at Hallville and Point of Rocks. At Rock Springs, two beds of coal are worked, as at Black Buttes, one four and one eight feet; and besides, as seen by the records of the borings for water made at this locality, and copied in Annual Report, 1872, p. 335, fourteen beds of coal were passed to the depth of seven hundred and twenty-

eight feet. This gives sixteen beds of coal above the great hard sandstone, which was passed by the drill from seven hundred and eighty to eleven hundred and eighty feet.

From Rock Springs to Evanston, the Lignitic is overlaid by the strata of the Green River group, which is formed of beds of shale, some calcareous, others sandy, with numerous strata of bituminous shale, but as yet no lignite seams, until, reaching Evanston, we find still heavy deposits of lignite coal, as recorded in the section (Annual Report, 1872, p. 338), from top of the hill to base:—

	Feet.
Conglomerate	40
Hard yellow, fine-grained, micaceous sandstone	32
Conglomerate, topped with coarse sandstone	37
Fine-grained and intermediate layers of coarse-grained sandstone	32
Conglomerate (lower banks)	27
Bituminous clay	10
Shale and clay banks, mostly covered	145
Sandstone in bank	11
Alternating beds of shale and shaly sandstone	106
Shaly sandstone, very hard, sometimes in bank, with dicotyledonous plants	11
Argillaceous shale, with ferruginous concretions and remains of plants	96
Coal	5
Clay and shale	12
Coal *	7
Clay	3
Main bed of coal, with four bands of slate	26
Shale and clay	8
Coal	5
Clay and shale	15
Iron ore	3
Clay and shale	15

I could still mention the Lignitic beds worked at Coalville, not far from Evanston; those of Sulphur Creek, near Beaver River, said to be seven and a half feet; those also of Wasatch County, in Utah, which, according to

* The lower part of this section is from Dr. A. C. Peale, Annual Report, 1871, p. 195.

Prof. Clayton, are of considerable importance, the prominent vein of the measure being thirty-two feet in thickness and of excellent quality, But the geological relation of these last lignite deposits is not as yet definitely ascertained, some of them being apparently Cretaceous. What I have said is more than sufficient to show the wide extent of the great Lignitic, its average thickness, and also its capacity and importance for the production of coal.

To ascertain the exact value of the Lignitic coal, numerous chemical analyses have been made and published. An analysis of coal of the Carbon Mines is given already in Dr. Hayden's Annual Report, 1869, p. 197. Mr. *J. P. Carson*, the chemist, finds in it 51.67 fixed carbon. In Report of 1870, the bituminous coal from the old Placière mines of San Lazaro Mountains, New Mexico, is analyzed mostly by Mr. Persifer Frazer, jr., and shows on eight different analyses an average of 60 per cent. of fixed carbon; that of Evanston, 49. At page 321 of the same volume, there is a very interesting comparative table of the result of chemical analyses of the coal of the more important seams of the southern basin, by Mr. James F. Hodge. From it are derived the following data:—Golden coal, fixed carbon, 45.57 to 47.58; Murphey's Mine, 44.41 ; Marshall's, 49.72 ; Boulder County, 47.30 to 50.65; Carbon, 49.72; Rock Springs, 54.46; Evanston, 50; Coalville, 48. From analyses recorded in my Report, 1872, the results are about the same. The Carbon coal has of fixed carbon between 49.30 and 51.65; Rock Springs, 52.45; from north of Trinidad a coal, of which I had choice specimens, has of fixed carbon 57.60; Cañon City coal, which is very rich in fixed gas, has 54.70 of fixed carbon, and that of the Raton Mountains 55. Most of the analyses quoted here, with a large number of others, are presented in a table of the Annual Report of 1873, pp. 112–114. Though, as everybody knows, the result of analyses present always marked differences, the compounds of each piece of coal taken from a mine being more or less varied, it is evident that the coal of the Western Territories is a lignite of high value and of a quality at least equal, if not superior, to the combustible mineral generally known and used in Europe under the appellation of lignite. The highest average of fixed carbon in European lignite is 67 to 68, and this very rarely; it generally averages 45 to 46. This subject, however, need not be considered further. Its relation to the fossil flora is far indeed, and it is sufficient to touch it in passing in order to omit nothing which may afford some knowledge of the characters of the Lignitic.

§ 3.—*The age of the Lignitic as indicated by its geological distribution and its fauna.*

The first explorers of the Great Lignitic seem to have recognized it as Tertiary; for in their narration, Lewis and Clarke mention that it overlies the Cretaceous series. The definition of the age is, however, not positively ascertained by the fossils which they collected from the upper part of the Cretaceous clay bed, where the coal seams commence, nor by those procured later by Nicolet from the same locality, for they were determined by Dr. S. G. Morton as Cretaceous.* Taylor asserts, however, that from specimens of plants and animals from the vicinity of Fort Union, near the confluence of the Yellowstone and Missouri Rivers, they derive incontestable proofs of a fresh-water formation. Taylor adds that the Upper Missouri Valley has yet to receive examination from scientific geologists, and that there can be no doubt but highly interesting results would follow from investigation in a field so rich and extensive. On the report of Mr. Harris, the associate of Audubon,† who ascended the Missouri to the mouth of the Yellowstone River, the committee to whom this paper was referred close their reports with the remark that the proofs thus afforded of a probably widely diffused fresh-water formation in the region of the Upper Missouri, reposing upon the Cretaceous strata, and imbedding remains of a manifestly Tertiary age, are just at this time invested with considerable interest, from their according with the discoveries, recently made by Captain Frémont, of the presence of other and probably extensive fresh-water Tertiary strata in the Oregon Territory.‡ Taylor himself, considering the brown-coal formations of the Northwestern Territories, calls them Tertiary.

Dr. Hayden rightly remarks, in the beginning of his report of 1874, that prior to the time when he began his explorations in 1854, the observations that had been made by various travelers in regard to the existence of coal beds in different parts of the West were of so indefinite a character that they cannot be used as evidence, though they may form a part of the early history of discovery. That the conclusions to which he arrived from the first on the Tertiary age of the Lignitic are not based upon superficial examination is sufficiently known by the numerous memoirs published by him from 1857 to

* Proceedings of Academy of Natural Sciences of Philadelphia, October, 1841.
† Proceedings of the Academy of Natural Sciences of Philadelphia, May, 1845.
‡ Taylor's Statistics, p. 177.

1861, and afterward by his annual reports. Considering his opinion on the age of the Lignitic, he remarks, in the last report:*—"It is well known that I have held with some tenacity the opinion that the coal formations of the West are of Tertiary age, and I still regard the Lignitic group as transitional or Lower Eocene until the evidence to the contrary is much stronger than any which has been presented up to the present time."

It has been seen already that, in his explorations of 1854, Dr. Hayden carefully surveyed the Lignitic beds along the Missouri River from their first appearance near Fort Clarke to the mouth of the Yellowstone, and then up that river to a point near the mouth of the Big Horn. "In all this distance, about six hundred miles, following the windings of the river, the Cretaceous beds appear but once, and then only along the bed of the river for a few miles, while the entire country, with this exception, is occupied with the Lignitic groups. It rests everywhere upon well-defined Cretaceous beds, No. 5, which we have all along regarded as the highest known in the West, and have received the name of *Fox Hills* group, from a locality on the Missouri River called the Fox Hills or Fox Ridge, where this formation was first studied and found full of Molluscan life.† There is a gradual passage upward from the black, plastic, shaly clays of No. 4, or the Fort Pierre group, to the yellow calcareous clays of the Fox Hills group, and at the upper portion the sediments are arranged in thin layers, very arenaceous, indicative of their deposition in turbulent as well as shallow waters. In these arenaceous sediments, the well-marked marine life ceases to exist, and soon after appear the brackish-water species." From this kind of formation of the Fox Hills group, it is not surprising that it is not of universal extent. It is the true transition group, locally of a thickness of five hundred feet, but it is not constant. For example, its presence is clearly marked from Rock Creek to Medicine Bow along the Union Pacific Railroad; but I have not seen it anywhere under the coal strata along the base of the Rocky Mountains, at least not with its characteristic fossils. At the Raton Mountains, and all around Trinidad, where the succession of the Lignitic to the Cretaceous is exposed at many places, the brackish beds overlying the Cretaceous No. 4 are already Lignitic by their characters; for they do not contain any traces of Cretaceous remains, but a profusion of fragments of dicotyledonous wood, evidently rolled with the

* Annual Report, 1874, p. 20.

† See section of the Cretaceous of Nebraska and Kansas in Cretaceous Flora, p. 14. It is copied from Dr. Hayden's Annual Report, 1870, p. 87.

sand by the waves. They there constitute the lower member of those heavy beds of sandstone, which have been remarked already as forming the base of the Lignitic, and which have in their remains, and also in their compounds, the same characters as the lower flaggy or shaly sandstone overlying Cretaceous No. 4. No trace of animal Cretaceous remains has been found in connection with them, neither in the south nor in the north Lignitic field. When Cretaceous No. 5 is not formed, the base of the Lignitic rests on No. 4.

In 1857, an account of the Tertiary of Nebraska was published by Messrs. Meek and Hayden, and the same year a map of the region bordering the Missouri River, together with sections and explanatory notes illustrating the geological structure of the country, was prepared by Dr. Hayden. The authors had then collected a great quantity of specimens of animal and vegetable remains from the base to the summit of the Lignitic group. Speaking of the animal remains which were studied by Dr. Leidy, of the vegetable fossils by Dr. Newberry and myself, and of the invertebrate by himself and Dr. Meek, Dr. Hayden says,* "*None of us doubted even their Tertiary age*"; an assertion forcibly resulting from the determination of the materials collected in the exploration. For, considering merely the Mollusk, we see in the volume of the Proceedings quoted above that of one hundred and fifty species of Mollusks described from the Fort Union group, fifty-four are of the Tertiary age, fifty strictly fresh-water species, and only four belong to genera supposed to inhabit salt or brackish waters. The more prominent genera to which these Mollusks are referred are *Ostrea*, *Unio*, *Pisidium*, *Corbicula*, *Potamomya*, *Melania*, *Melampus*, *Vivipara*, etc., all of Tertiary types.

The section of the Tertiary measures as recognized by Dr. Hayden finds its place here as elucidation of the distribution of the essential groups of animal fossils which characterize the formation. The Tertiary divisions indicated by the distribution of fossil plants may present some differences. The subject has to be examined after the descriptive part of the vegetable remains. The section is copied from Dr. F. V. Hayden, Annual Report, 1874, p. 23:—

* Proceedings of the Academy of Natural Sciences of Philadelphia, May, 1857.

Names.	Subdivisions.	Thickness.	Localities.	Foreign equivalent.
Loup River beds.	Fine loose sand, with some layers of limestone; contains bones of *Canis, Felis, Castor, Equus, Mastodon, Testudo*, etc., some of which are scarcely distinguishable from living species.	300 to 400 feet.	On Loup Fork of Platte River, extending north to Niobrara River and south to an unknown distance beyond the Platte.	Pliocene.
White River group.	White and light drab clays, with some beds of sandstone and local layers of limestone. Fossils, *Oreodon, Titanotherium, Chœropotamus, Rhinoceros, Anchitherium, Hyænonodon, Machairodus, Trionyx, Testudo, Helix, Planorbis, Limnea*, petrified wood, etc.; all extinct. No brackish-water or marine remains.	1,000 feet or more.	Bad Lands of White River, under the Loup River beds on Niobrara, and across the country to the Platte.	Miocene.
Wind River deposits.	Light gray and ash-colored sandstones, with more or less argillaceous layers. Fossils, fragments of *Triongx, Testudo*, with large *Helix, Vivipara*, petrified wood, etc. No marine or brackish-water types.	1,500 to 2,000 feet.	Wind River Valley; also west of Wind River Mountains.	(?)
Fort Union group; Lignite group.	Beds of clay and sand, with round ferruginous concretions, and numerous beds, seams, and local deposits of lignite; great number of dicotyledonous leaves, stems, etc.; *Platanus, Populus*, etc., with very large leaves of true Fan Palms. Also, *Helix, Melania, Vivipara, Corbicula, Unio, Ostrea, Potamomya*, and scales of *Lepidotus*, with bones of *Trionyx, Emys, Compsemys, Crocodilus*, etc.	2,000 feet or more.	Occupies the whole country around Fort Union, extending north into the British Possessions to unknown distances; also southward to Fort Clarke; seen under the White River group, on North Platte River, above Fort Laramie; also on west side of Wind River Mountains.	Eocene.

It appears positive that the Fort Union group cannot be separated from the Colorado Lignitic, or rather that they are both united under the Laramie group into a continuous formation. Dr. Hayden has remarked it in the same report when he says that the Lignitic group descends northward along the east base of the Laramie Range, and reappears on its other side about ten miles south of the Union Pacific Railroad. It is therefore continuous.

When both areas, the north and south, are considered in regard to their fossil faunas, they show, however, a marked difference, not in the characters of the species of Mollusks, but in the nearly total absence of invertebrate fossils south of the Laramie Range. I do not know of any locality where fossil shells have been seen in the Southern Lignitic Basin except at Marshall's, where a bed of clay iron ore, above No. 5 of the section, has a profusion of fragments of Oyster shells (*Ostreo subtrigonalis?*). The same species, remarks Dr. Hayden, is abundantly found near Brown and O'Bryan's coal mine, about twenty miles southeast of Cheyenne, also in the Colorado Basin. Anyhow, no remains of invertebrates identifiable as of Cretaceous age have been found in the true Lignitic Measures of the Colorado Basin from Cheyenne to the Raton Mountains. In this whole area, therefore, of the Lignitic, represented by what is called the Fort Union group in the north and the Colorado Basin in the south, we have, from the distribution of the strata and from the fossil faunas, evidence only of the Tertiary age of the formation.

There is some more difference in the Lignitic of the so-called Bitter Creek series, and, as remarked by Prof. E. D. Cope in his Report, 1873, p. 438, the authorities on this formation have presented views more or less at variance with those entertained by him. The whole range from Black Butte to Point of Rocks is the slope of an anticlinal whose axis is at Salt Wells; and from the first locality to Point of Rocks or to Salt Wells, in a northeast direction, the series of rocks is passed, which, in their superposition by the southwest dip, has a thickness of three to four thousand feet, according to the measurements of Messrs. Meek and Bannister. A huge Saurian discovered by Prof. Meek in the overlying and burnt shale of the main coal of Black Butte has been identified by Prof. Cope as a Dinosaurian (*Agathaumas sylvestris*) of Cretaceous type. Lower in the series, below Black Buttes, at Hallville, Prof. Meek has found shells whose character is not quite definite, but which he considers as Cretaceous, though the same locality was admitted by him in his report of 1870 as Tertiary. But my lamented friend, who has done so much for the paleontology of North America, has so clearly discussed the question of the character of the fauna of the Bitter series formations that I consider it a duty to quote some of the more pertinent passages of the introduction to his list and description of fossils in the Annual Report of Dr. F. V. Hayden, 1872. He says (p. 457):—

"Returning to the question of the age of Bitter Creek series, it may be

stated, in the first place, that Emmons evidently regarded it as Cretaceous, as may be seen from his remarks in Mr. King's report, published in 1870, while Dr. Hayden favored the conclusion that it is a marine Tertiary group, or a transition series between the Tertiary and the Cretaceous, in his reports of that and the following year."

"The only fossils I had ever seen from this formation previous to visiting the region during the past summer were two species of *Ostrea* and one of *Anomia* from Point of Rocks, and two shells, one or possibly both related to *Corbicula*, from Hallville. Those from Point of Rocks I referred to the Cretaceous, placing them in the Cretaceous list in Dr. Hayden's report, 1871. This I did mainly because there were among them no fresh-water or strictly brackish-water types, while up to this time we knew of no Tertiary of exclusively marine origin in all this internal region of the continent. I was also in part influenced in making this reference by the similarity of one of the Oysters to a Cretaceous species found in California, while the *Anomia* likewise closely resembled a Texas Cretaceous shell described by Roemer under the name of *Ostrea anomiæformis*, which certainly seems not to be a true Oyster. The two shells from Hallville, however, I referred to the Eocene, not only because they were closely allied to Eocene brackish-water forms from the Paris Basin (peculiar depressed and elongated form of *Corbicula*), but because I was not aware at the time that the Hallville mines occur in the same formation as the Point of Rocks beds, nor even within fifty to seventy-five miles of the same locality.

"On visiting these localities, however, last summer, I was somewhat surprised to find that the Hallville mines are only some seven or eight miles from Point of Rocks, and belong to the same geological formation. A careful examination, also, soon rendered it evident that all of the rocks for sixteen hundred to eighteen hundred feet or more above the Hallville coal beds, up to and including the stratum in which we found the large reptilian remains at Black Buttes, and for even a little greater thickness below the Hallville horizon, certainly belong to the same group or series of strata, and that fresh- and brackish-water types of fossils occur along with salt-water forms at all horizons wherever we found any organic remains throughout this whole series."

From this fact, Prof. Meek was induced to modify his views, and to consider the whole series Cretaceous, by some reason which I do not consider as

conclusive; for it seems that the author should rather have admitted Point of Rocks, with the two species of *Ostrea*, as Tertiary, than to have considered Hallville as Cretaceous, for the species of Mollusks are not more evidently Cretaceous than are the Oyster shells of Point of Rocks. The *Ostrea* of Marshall and Bryant's coal mines are not less marine species than those of Point of Rocks. This seems the more surprising, that, considering further the question of the age of the group, after discovering in the rocks of the Bitter Creek series between three and four times as many species of fossils as had been known from the same, the celebrated professor remarks, with that admirable candor of mind which adorns all his work:—

"Although partly committed in favor of the opinion that this formation belongs to the Cretaceous, and still provisionally viewing it as most probably such, I do not wish to disguise or conceal the fact that the evidence favoring this conclusion to be derived from the Mollusks alone, as now known, is by no means strong or convincing. The genera are probably all common both to the Cretaceous and Tertiary as well as to the present epoch, unless *Leptesthes* and *Veloritina*, which have been separated subgenerically from *Corbicula*, may be distinct genera; the European representatives of these being mainly, if not entirely, Tertiary forms, while *they* do not appear to include living species. *Goniobasis* is also not known in either Cretaceous or Tertiary rocks of the Old World, but then it is an American type, greatly developed among our existing *Mollusca*, as well as in the far Western Tertiary Rocks, and we can scarcely doubt that it will be found in unquestionable Cretaceous beds there, even if some of the imperfect specimens already known from the same are not such. It should be remembered, however, that even the specimens I have referred to this genus from Bitter Creek beds are not in a condition to show the aperture beyond doubt to possess the characters of *Goniobasis*.

"The entire absence among the fossils yet known from this formation of *Baculitis*, *Scaphites*, *Ancyloceras*, *Ptychoceras*, *Ammonites*, *Gyrodes*, *Anchura*, *Inoceramus*, and all the other long list of genera characteristic of the Cretaceous, or in part also extending into older rocks, certainly leaves its Molluscan fauna with a strong Tertiary facies. Nor can we quite satisfactorily explain this away, on the ground that the water in which this series of rocks was deposited partook too much of the character of that of an estuary, to have permitted the existence of any of these marine genera, because we do find in it the genera *Ostrea*, *Anomia*, and *Modiola*, which probably required water

salt enough to have permitted the existence of *Inoceramus*, *Anchura*, and *Gyrodes*, if not of some or all of the genera mentioned above. Indeed, at Coalville we find *Inoceramus* associated with some brackish-water types, and the additional Cretaceous genera *Cyprimera*, *Anchura*, *Gyrodes*, etc., in closely associated beds."

"When we come to consider the invertebrate fossils yet known from this formation in their specific relations, we find all, with possibly two or three exceptions, new to science, and different from those yet found either at Bear River, Coalville, or indeed elsewhere in any established horizon; so that we can scarcely more than conjecture from their specific affinities to known forms as to the probable age of the rocks in which we find them. Considered in this respect, their evidence, however, is conflicting. Two of the species of *Corbula* for instance (*C. tropidophora* and *C. undifera*) are most similar to species found in the brackish-water beds at the mouth of Judith River in the Upper Missouri, that we have always considered Lower Tertiary, though there are some reasons for suspecting that they may be Upper Cretaceous. A *Corbicula* both from the Black Buttes and Point of Rocks localities is even so very nearly like *C. cytheriformis* from the Judith River beds that I have referred it doubtfully to that species."

"Again, the species *Anomia gryphorhynchus*, found so abundantly at Point of Rocks in the same bed with the above-mentioned *Corbicula* and *Corbula tropidophora*, so closely resembles a Texas Cretaceous shell described by Roemer under the name *Ostrea anomiæformis* that I am strongly inclined to suspect they may be the same; though whether identical or not, at least our shell is certainly not an Oyster, as it has its muscular and cartilage scars precisely as in *Anomia*, while its beak is never marginal, and it has no ligament-area. In all of these (and indeed in all other characters), the Texas shell as illustrated by Roemer seems to agree precisely with ours, excepting that he represents it as having only one central muscular scar instead of three. In many of our specimens, however, the two smaller of these scars are very obscure, and might be easily overlooked. It is true he figures a nearly flat valve, without any byssal perforation, and a convex one as opposite valves, and if they are such the shell would certainly not be an *Anomia*. Among a large collection of our shells, including thousands of specimens, however, I have not yet seen a single perforated valve, though they vary much in convexity, some of the valves being nearly as depressed as the one Roemer figures as

the upper valve, supposing it to be an Oyster. If these depressed specimens in our collection are opposite valves to the convex ones, then the shell would neither be an *Ostrea* nor an *Anomia*, but would almost certainly fall into Morris and Lycett's genus *Placunopsis*, which, so far as known in Europe, is a Jurassic group. Consequently, if our shell should fall into that genus, it would, when viewed in connection with its associates and all the other known facts, furnish a strong argument in favor of the formation being at least as old as the Cretaceous. There are good reasons, however, for believing that these depressed specimens, as well as the convex ones, are all upper valves of the same shell, only modified in convexity by accidental circumstances of station, as their slight obliquity, as seen, for instance, in a look at the interior of both, is found to be in the same direction instead of the reverse, as would be the case if they were opposite valves of the same shell; while among thousands of specimens no example of a depressed and a convex valve united has been seen, nor have any been found that would come near fitting together."

"On the other hand, the Corbiculas are decidedly Tertiary in their specific affinities, as well as in their subgeneric; *C. fracta*, for instance, and *C. crassatelliformis*, from the Hallville mines, being very closely allied to Paris Basin Tertiary forms, the first-mentioned species being the type of a subgenus, so far as known, peculiar to the Tertiary elsewhere. The same may also be said of *C. cytheriformis*, which also seems to belong to a group (*Veloritina*) peculiar to the Tertiary in Europe."

"But the most surprising fact to me, supposing this to be a Cretaceous formation, is that we found directly associated with the reptilian remains at Black Buttes a shell I cannot distinguish from *Viviparus trochiformis*, originally described from the Lignitic formation at Fort Clarke, on the Upper Missouri, a formation that has always been regarded as Tertiary by all who have studied its fossils, both animal and vegetable. The specimen mentioned does not show the aperture nor all the body-volutions, but, as far as can be seen, it agrees so exactly with that very peculiar species in size, the form and proportion of its volutions, the slopes of its spires, its surface-markings, the nature of its suture, and, in fact, in every respect, so far as can be seen, that I have scarcely any doubt of its identity with the same."

In resuming his remarks, Prof. Meek further states, p. 461, § 7 to 9:—

"That on the one hand, two or three of its species belong to sections or subgenera (*Leptesthes* and *Veloritina*) apparently characteristic of the Eocene

Tertiary of Europe, and are even very closely allied to species of that age found in the Paris Basin; while, on the other hand, one species seems to be conspecific with, and two congeneric with (and closely related specifically to), forms found in brackish-water beds on the Upper Missouri, containing vertebrate remains most nearly allied to types hitherto deemed characteristic of the Cretaceous.

"That one species of *Anomia* found in it is very similar to a Texas Cretaceous shell, and perhaps specifically identical with it; while a *Viviparus*, found in one of the upper beds, is almost certainly identical with the *V. trochiformis* of the fresh-water Lignite formation of the Upper Missouri, a formation that has always, and by all authorities, been considered Tertiary.

"That the only vertebrate remains yet found in it are those of a large reptilian (occurring in direct association with the *Viviparus* mentioned above), which, according to Prof. Cope, is a decidedly Cretaceous type, being, as he states, a huge Dinosaurian."

"It thus becomes manifest that the paleontological evidence bearing on the question of the age of this formation, so far as yet known, is of a very conflicting nature, though, aside from the Dinosaurian, the organic remains favor the conclusion that it is Tertiary."

Prof. Cope has surveyed with the greatest care the whole series under consideration, and found, from the lowest marine coal-bearing formation to the Saurian bed of Black Buttes, an uninterrupted Cretaceous fauna, as indicated by remains of vertebrate animals. He therefore, after considering the facts exposed in favor of both opinions on the Cretaceous or the Tertiary age of this Lignite of the Bitter Creek series, comes to the conclusion that there is no alternative but to accept the results, that a Tertiary flora was contemporaneous with a Cretaceous fauna, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in the geological times.*

As no kind of Cretaceous animal remains have been discovered in the Lignite of Colorado, none either in that of the north, generally called the Fort Union group, the question of age essentially bears upon that Bitter Creek series. The line of demarkation between the Cretaceous and the Tertiary is placed by Prof. Cope above the Black Buttes Saurian bed. Prof. King fixed it in the middle of the series, near Point of Rocks; and, from my

* Annual Report, 1873, p. 442.

own observations when I explored the range, I found it near Salt Wells, or below Point of Rocks. If, then, we find the fossil flora of this last locality agreeing in characters with that of Black Butte, if this one bears the same degree of relation to that of the Colorado Basin, and to that of the North Lignitic or of the Fort Union group, we shall have to conclude that these land formations of the great Lignitic are contemporaneous, and the question of their age has to be decided, I think, by the comparison of the vegetable types represented in the whole Lignitic formation. This can be done only after the description of the species and the exposition of their characters.

PART II.

DESCRIPTION OF THE TERTIARY FOSSIL PLANTS.

CRYPTOGAMÆ.

FUNGI.

We cannot doubt the existence of vegetables of this order in former geological epochs, when there was a profusion of woody plants whereupon they could thrive as parasites, as they do now upon organs of the same kind. It is, however, clear that all the Fungi of soft, fleshy substance, like those which we see in the spring and the fall, especially upon the wet ground, and which are soon decomposed after their apparition, cannot have left any trace of their existence in a petrified state. Their former life is revealed, however, by the fossil remains of insects deriving their food from fleshy mushrooms only. The Cryptogamous kinds which vegetate upon the bark and the leaves of trees, and which are sometimes persistent, even when the wood or the leaves are passing into a state of decomposition, are the only ones which may be preserved by fossilization, and which we may expect to recognize in a few instances. The characters of the Cryptogamous plants, however, are mostly established by organs of fructification which are unperceivable to the eyes, and, being in most cases enclosed into the substance of the plants, they cannot be discovered in a fossil state; therefore the determination of all the Cryptogamous, even that of the *Algæ*, is very unreliable. Spots of different colors, small papillæ, also similar to those which are imprinted or engraved by living fungi upon stems and leaves of the present flora, are often remarked upon petrified substances of the same kind, even in fossil remains of the Carboniferous. But they may be mere imitations produced by the deposit of particles of stony matter or by the impregnation of foreign substances, especially of iron; and, as their determination is therefore still more uncertain

and of little importance, I have generally omitted describing them. The few species of Cryptogamous described and figured in this memoir are the only ones which seemed distinctly referable to plants, and they are published in order, especially, to show the existence of this class of vegetables in the Lower Tertiary measures of this continent.

SPHERIA, Haller.

Spheria lapidea, Lesqx.

Plate I, Fig. 3.

Spheria lapidea, Lesqx., Annual Report, 1872, p. 373.*

Perithecia (receptacles) round, highly convex, one to two millimetres broad, growing in lineal series from under the bark, and piercing it before opening; borders irregularly lacerated; substance membranaceous or coriaceous, whitish.

This species is of subcortical growth, upon a petrified fragment of wood, which has part of the bark preserved. The few perithecia under the bark of the specimen in *a* are like small warts whose surface is rough and opaque. Just at the borders of the bark, in *b*, the receptacles have perforated it in irregular circles with lacerated borders; and still lower, in *c*, the intumescence of the bark produced by the growth of the perithecium is seen prominent and smooth, the epidermis being still entire, or not yet pierced through by the plant.

HABITAT.—Upon a fragment of wood, Raton Mountains, New Mexico.

Spheria myricæ, Lesqx.

Plate I, Fig. 4.

Spheria myricæ, Lesqx., Annual Report, 1872, p. 390.

Perithecia punctiform, minute, either sparse or in circle, forming round spots.

The receptacles of this species are punctiform, very small, sometimes irregularly scattered, more generally disposed in circles, forming rings one millimeter in diameter, the centre of which is clear and of a light color. It resembles *Xylomites varius*, Heer (Flor. Tert. Helv., plate i, fig. 9), but in our plant the punctate form of the perithecia is distinctly recognized with the glass.

HABITAT.—Upon leaves of *Myrica Torreyi* found at Black Butte, Wyoming, and of *M. nigricans*, from specimens of Green River Station (*Dr. F. V. Hayden*).

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* The numerous quotations of the Annual Reports of Dr. F. V. Hayden's Geological Survey of the Territories are hereafter indicated as above. The dates indicate the years of publication of the Reports.

Spheria rhytismoides, Lesqx.

Plate I, Figs. 5, 5 *a*.

Spheria rhytismoides, Lesqx., Annual Report, 1874, p. 308.

Perithecia punctiform, placed in a simple circular row, larger than in the former species, with borders irregular.

This species composes, like the former, circular spots, by the disposition of its receptacles in a circle. These, however, are larger, five to six only in a simple row, either separated or more generally connected. The spots vary from one to two millimeters in diameter.

HABITAT.—Upon the stem of *Caulinites sparganioides* at Black Butte.*

Sclerotium rubellum, Lesqx.

Plate I, Figs. 2–2 *f*.

Sclerotium rubellum, Lesqx., Annual Report, 1872, p. 375.

Perithecia oval or oblong, obtuse, convex when young, then concave or channelled; spores of a red color.

The different phases of development of this fungus are seen in figs. 2 *a* to 2 *f*. Before its maturity, the surface is convex, by an inflation of the receptacle, as in fig. 2 *a*. I consider this as the first stage of its growth. Later, the central part is depressed, and the borders appear somewhat elevated around it. It then becomes either concave (fig. 2 *b*), or channeled (fig. 2 *c*), or flat (fig. 2 *d*). When the perithecia are ripe, they appear opened, and the inside is covered with a punctate red surface resembling a pulverulent matter like spores. I was, however, unable to detach any of it, or to trace any form of organism in this colored central part. The form of these perithecia is very variable, sometimes small and nearly round, more generally linear-oblong, obtuse, two to four millimeters long, rarely broader than one millimeter, generally intermediate to the veins of *Flabellaria*, and like them buried under the epidermis.

HABITAT.—Upon fragments of leaves of *Flabellaria Zinkeni?*, Golden, Colorado.

Sclerotium pustuliferum?, Heer, mentioned (Annual Report, 1871, p. 300) as growing upon the leaves of *Cyperus*, is too indistinct for description, and cannot be figured.

LICHENES.

The great scarcity of fossil remains of Lichens is perhaps more remarkable than that of the Fungi. Professor Göppert, in his study of the vegetable fragments preserved in succin, or amber, has demonstrated the existence

* All the species without name of the discoverer are described from specimens found by the author.

of plants of this order in former geological times, and has been able to refer most of them to species allied or even identical with those of our epoch. The Lichens mostly inhabit the bark of trees or closely adhere to the surfaces of stones or rocks. Though hard they may appear, they are composed of cellular tissue, easily destroyed by prolonged immersion, and it is therefore extremely rare to find any species of this genus upon the bark of old trees when their decomposition is advanced. They are also generally attached to the epidermis, which is rarely preserved with the bark of decaying wood. Though it may be, excepting the species described from the succin, very few other Lichens have been recognized as yet in a fossil state. Göppert remarks the presence of a *Verrucaria* and two *Graphides* in the Lignitic of Germany as an extremely rare occurrence; and Schimper says that he has been able to find once only a fossil Lichen represented by a few specimens of *Lecidea*. It was only after a careful study of the characters of the remains described below that they were recognized as positively referable to Lichens.

OPEGRAPHA, Ach., Nyl.

Opegrapha antiqua, Lesqx.

Plate I, Figs. 1–1 *c*.

Opegrapha antiqua, Lesqx., Annual Report, 1872, p. 390.

Perithecia one to four millimeters long; linear or slightly enlarged in the middle; pointed or obtuse; more generally united two, three, or four in opposite directions; sometimes flexuous or curved.

The form of the small plants, or of their perithecia, is distinctly represented upon the specimen, a piece of clay wherein the nuclei have either been left imbedded or have deeply stamped their outlines. They are comparatively small, scarcely half a millimeter broad, either in a line or curved in various ways; sometimes short, oblong, enlarged in the middle, joined two, three, or more by the points, and diverging star-like; sometimes single, linear, falcate or hooked, and obtuse at both ends. From their impressions, they appear to have been upraised above the surface to which they were attached, slightly grooved in the middle, with round borders. The inside part of the cavities has generally in the middle, when the perithecia or nuclei are out, a streak of black carbonaceous-like matter, as seen on the right of the branch (enlarged part, fig. 1 *a*). The print of the nuclei is marked, figs. 1 *b*, 1 *c*, still more enlarged. As resulting from an impression, the inside part should be convex. The borders of these small plants seem to have been detached, or are too close to have allowed the penetration of clay between them. The relation of this species is especially with *Opegrapha astræa*,

Tuck., of Texas. It is also more distantly comparable to *Graphis elegans*, Nyl., of Oahu.

HABITAT.—Black Butte; upon a piece of clay shale, the counterpart or impression of a stem of *Caulinites sparganioides*.

ALGÆ.

As for the Lichens, the exact determination of the fossil remains of marine plants generally named Fucoids is not possible. Their forms, however, are sometimes definable, and persistent also; and thus, if all their characters are not positively determinable, and if even their generic references are mostly uncertain, they may be at least compared, separated in groups under definite names, and used for the identification of geological formations. Still for this, they are not as reliable as land plants. Their types appear to be preserved for long space of time, on account of the slow modifications of the element wherein they live. Hence we find some species present in two formations whose age is indicated as different by the remains of land plants. The study of the fossil *Algæ* is also rendered difficult by their distribution in series of rocks, especially of sandstone, of some thickness. Growing up as fast as the sand is heaped around and covers them, they send their branches in every direction, sometimes filling the rocks by their multiple subdivisions in such a way that even large specimens do not represent the characters of their general outlines. The most of the *Algæ* are moreover of a soft substance, easily destroyed by decomposition, and then flattened and mixed together in an amorphous mass. Their former existence is often recognized only by flakes of carbonaceous matter, or even by the mere discoloration of the rocks. Heavy beds of sandstone in New Mexico and Colorado, especially, contain a profusion of fossil remains of *Algæ*, and if it had been possible either to cut them from the rocks or to study and to figure them in place, a large number of very diversified forms could have been represented and described here.

HALYMENITES, Sternb.

Halymenites striatus, Lesqx.

Plate I, Fig. 6.

Halymenites striatus, Lesqx., Annual Report, 1872, p. 373.

Frond large, dichotomous, erect; branches short, obtuse, cylindrical, or more or less flattened by compression; surface irregularly striate.

This species is related to the following by its ramification, which is extremely variable. Sometimes the branches on a more or less obtuse angle

of divergence come out from a tumescence of the principal axis, as represented partly in fig. 6; sometimes they are comparatively small and in right angle, penetrating the sandstone in every direction and in such a way that, as the remains are extremely abundant, it is very difficult to separate them even in small fragments. The surface is more or less evidently striate; the young branches are nearly smooth, the larger stems deeply, somewhat irregularly wrinkled or rather veined, as the striæ appear here and there parallel and distinct to the eye, but not permanent upon wide surfaces.

HABITAT.—Sandstone underlying the coal beds at the base of the Raton Mountains, New Mexico.

Halymenites major, Lesqx.

Plate I, Figs. 7, 8.

Halymenites major, Lesqx., Annual Report, 1872, pp. 373, 390.

Frond of the same size and mode of division as in the former species; surface marked by round contiguous or separate tubercles.

The frond of this species appears to have been still larger than that of the former, cylindrical, rarely and slightly flattened; pinnately, or dichotomously, or abnormally divided in shorter, smaller branches, very variable in length; surface covered with round, elevated, or half-globular tubercles, two to five millimeters broad, and as thick as broad. As in the former species, the divisions from the main axis often proceed from an intumescence, or knot, where from two to three, or even four branches come out diverging all around. In other cases, the branches are merely alternately forking or dichotomous, and regular in their divisions. The tubercles of the surface are either distant or separate, as in fig. 8, or crowded and connected on the borders, as in fig. 7; more or less irregular and variable in size, even upon the same fragment, but always present. Even the specimens which appear to have been exposed for a long time to atmospheric influence, or to abrasions by water, show distinctly the scars of the impression of the tubercles by deep circular lines upon the stony compound.

HABITAT.—This species, extremely common in the sandstone of the Lignitic measures, is found at various stages; at Black Butte, Golden, Carbon, and especially at the Raton Mountains, with the former. Prof. Meek found it in the sandstone of Coalville, which he considers as of Cretaceous age. It has been sent nearly with every lot of specimens collected by Prof. Hayden and his assistants. Its highest station is at Carbon.

Halymenites minor?, F. O.

Plate I, Fig. 9.

Halymenites minor, Fisch., Oost. D. Foss. Fuc., pp. 56, 65, pl. xiii, xvi.—Lesqx., Annual Report, 1872, p. 373.

Branches small, half a centimeter broad; tubercules small and flat.

The European species is known to me from description only, and from a small fragment figured in *Urwelt der Schweitz* by Heer. I should have considered the fragment figured here as a branch of the former species, if the tubercles were not much smaller and all flattened, apparently in a natural way, and not by erosion. It is, however, admissible that, variable in its size, its ramification, and other characters, as is the former species, it may be represented also by fragments like the one doubtfully referred to *H. minor*, a species which, according to Schimper, is already uncertain, and established from insufficient materials.

Marine plants of the same type as these have been remarked in Europe in the Jurassic and the Eocene formations. Count Saporta has represented, in *Pl. Jurassiques*, 1st suppl., pl. lxviii, fig. 3, under the name of *Phymatoderma Cœlatum*, Sap., a species of *Algæ*, similar to this *H. minor*, and Watelet has, in his *Plantes Tertiaires du Bassin de Paris*, an Eocene formation, a species remarkably like *H. major*.

HABITAT.—Sandstone beds of the Lower Lignitic; Raton Mountains, etc.

DELESSERIA, Lamx.

Delesseria fulva, Lesqx.

Plate I, Fig. 10.

Delesseria fulva, Lesqx., Annual Report, 1872, p. 376.

Frond membranaceous, dichotomous, long, linear, with an irregularly inflated middle nerve; divisions linear, distant, alternate, obtuse, enlarged and lobed at the point.

This fucoidal frond, or probably a mere branch of a frond, is remarkably fine, its brown-reddish color contrasting with the white sandstone wherein it is imbedded. The specimen was originally larger than the figured part, but had to be cut from a rock in place, and, the stone being hard as flint, it was impossible to break it out in its full shape. The part left out, however, did represent only one more of the lower divisions, of which some traces are left, indicating its length and its increasing width toward the top. The main branch, measuring twenty centimeters long, before breaking it, is a little more than one centimeter broad, dichotomous, the lower branches more distant and longer than the upper ones, nearly all equally dilated toward the

top, where they are cut in two or three irregular, short, pointed or obtuse lobes. The main stem and the divisions have in the middle an inflated large nerve, more or less distinct, but traceable in the whole length and forking with the branches, at a distance below the sinuses; the substance of the plant appears membranaceous or subcoriaceous, somewhat thick, as seen upon the borders, which, here and there, are slightly raised above the stone in their undulations.

The nearest relation of this species among the fossil plants is *Delesserites sphærococcoides*, Ett., *Eoc. Fl. des Monte Prom.*, p. 8, pl. i, fig. 1. The affinity is still more distinctly marked with some species of the present marine flora, *D. alata*, *D. sinuosa*, etc., but especially with the fine *Botryoglossum platicarpum*, Kutz, of California. Indeed, the coriaceous or cartilaginous substance of this species rather refers it to this last genus than to the delicate membranaceous fronds of *Delesseria.*

Of the eight fossil species of this last genus described by European authors, seven belong to the Eocene, or the Lower Tertiary, four being from Mount Bolca and from Radoboy, and two from Mount Promina. The other species described by Sternberg as an *Haliserites*, *H. Reichii*, and considered by Schimper as a *Delesseria*, is from the Upper Cretaceous of Niedershoena in Saxony.

HABITAT.—On upraised white sandstone rocks under or between the coal-beds of Golden, Colorado.

CAULERPITES, Schp.

Caulerpites incrassatus, Lesqx.

Plate I, Figs. 11, 12.

Delesseria incrassata, Lesqx., Annual Report, 1872, p. 374.

Frond simple (?); laminæ either trifid from the base or simple, sessile, close, obovate, narrowed downward; surface rugose.

The specimen seems to represent the upper part of a frond by three divisions, or laminæ, apparently joined at their base to a common axis. These segments, deeply impressed into the stone, are either rounded or slightly cuspidate at the top, gradually narrowed toward the base, as seen in fig. 12. From irregular, half-round scars, represented upon an indistinct continuation of the axis, fig. 11, it seems as if the laminæ had been sessile, half embracing; but the specimen does not show precisely any trace of divisions between the segments, and it is therefore uncertain if they were separated or connected at the base, opening altogether at the upper point of the axis as verticillate, or

successively unfolding upon another as alternate. The substance of the plants seems, from the deep impressions, to have been very thick and cartilaginous or hard, the surface is rugose in the length, or rather deeply wrinkled, as if the laminæ had been compressed on both sides; and the borders, irregularly undulately lacerated, are either round or slightly cuspidate or even emarginate at the top.

Though the relation of this species to the genus *Caulerpa* is not distinctly marked, its affinity with *Delesseria* is still less positive. To this last genus it is related only by the outlines of its flat, thick segments, while it is referable to *Caulerpa* by the mode of attachment of its divisions, comparable to that of *Caulerpa ericifolia*, Ag., and by their form and the thick cartilaginous substance, of the same character as in *C. prolifera*, Lam., two species of Florida.

Some fragments of another species, described in Annual Report, 1872, p. 374, under the name of *Delesseria lingulata*, have not been figured, being too incomplete and of a too uncertain relation. They appear sparsely and separately strewn upon the sandstone, like detached fragments of some compound fronds, or like the sacs of some *Ulvaceæ*, flattened by compression. The more complete of these, two centimeters long, twelve millimeters broad, is rounded at one end, broken at the other, slightly contracted in the middle, and marked in its length by a costa. But for this last character I should have considered these fragments as referable to the former species.

HABITAT.—Raton Mountains, New Mexico, in sandstone; both forms.

CHONDRITES, Schp.

Chondrites subsimplex, Lesqx.

Plate I, Fig. 13.

Chondrites subsimplex, Lesqx., Annual Report, 1872, p. 373.

Frond cylindrical, more or less flattened by compression, with rare, dichotomous, long, flexuous branches, mostly of the same size in their whole length.

This species is found generally flattened, with its expanded, long, flexuous branches, covering large slabs or passing across layers of shaly sandstone. Sometimes the filaments, or fronds, appear simple, linear, like those of *Halymenites lumbricoides*, Heer, Urw., p. 244, pl. x, fig. 11, only longer, thicker, and broader, not granulose; rarely they branch by a simple forking of the main axis, preserving the same size; some of the divisions, however, gradually decrease in size to a round point half as broad as the main stem. The surface is irregularly roughened, especially slightly wrinkled across along the

borders, and the middle is generally marked by a depression which seems to indicate a fistulous character of the stem and its divisions.

HABITAT.—Base of the Lignitic formations, Raton Mountains, New Mexico.

Chondrites bulbosus, Lesqx.

Plate I, Fig. 14.

Chondrites bulbosus, Lesqx., Annual Report, 1872, p. 273.

Frond flattened, irregularly, subpinnately divided in opposite or alternate branches, close to each other, or distant, short, inflated, some of them like irregular tubercles.

Mere fragments of the branches of this species could be obtained for illustration and description. The mode of division is very irregular; generally the main axis is slightly larger than the primary branches, three to five millimeters broad and irregularly dichotomous. The divisions, however, are directed either in right angle or upward and downward in the same fragment, and sometimes linear, sometimes inflated, taking the most diversified and irregular appearances, or inordinately inflated and narrowed. This species finds analogous representatives in *Halymenites varius* and other Algoids, described by Sternberg under the same generic name, from the Jurassic formations; the Tertiary species differing merely by its smooth surface and the more distinctly inflated branches.

HABITAT.—Raton Mountains, near Trinidad, New Mexico; base of the Lignitic formations.

FUCUS, Linn.

Fucus lignitum, Lesqx.

Plate LXI, Figs. 24 and 24 *a*.

Fucus lignitum, Lesqx., Annual Report, 1874, p. 296.

Frond flattened, irregularly dichotomous; branches diverging obliquely; branchlets short, terminal, linear, divaricate, tufted, forking at the point.

The fragment figured here is the only part of the plant represented upon the specimens. The lowest branches are four millimeters broad at the base, but the size of the branchlets diminishing nearly one-half at each dichotomous division, the terminal ones are very slender, scarcely half a millimeter broad. The upper divisions are like the first ones, short, split or forking at the point, and divaricate. The substance is membranaceous and yellowish, We have here evidently mere fragments of apparently large compact fronds like those of the living *Fucus canaliculatus*, Agh., common along the coasts of the Baltic Sea, and which appears closely related, by its membranaceous consistence, its mode of division, and the form of its branchlets, to the species

described here. This *Fucus* has been found in a fossil state in the Tertiary formations of Spitzbergen, as recognized by Heer. Another species, *Sphærococcites crispiformis*, (Sternb.) Schloth., Petref., i, p. 35, pl. iv, fig. 1, from the Lignitic Tertiary of Bohemia, is also related to the American species.

HABITAT.—Point of Rocks, Wyoming Territory (*Dr. F. V. Hayden*).

CHARACEÆ.

We have to pass over this order of plants without mentioning, as referable to it, any fossil species from this continent. It is indeed peculiar that remains of this kind have not been discovered as yet in our Tertiary measures, for the plants of this genus are quite as frequent in the shallow lakes, the ponds, and the calcareous springs of North America as they are in Europe. The fossil *Characeæ* are mostly known by their seeds, which, though small, could be easily discovered in the soft black shale or clay of the Lignitic measures, where they should be carefully searched for by the collectors of paleontological remains. The seeds vary in size from one-half to two millimeters, and are easily recognized, though small they may be, by their round-oval form, and their surface, upon which the valves are generally marked by distinct spiral lines. Of the thirty-seven species described by European paleontologists, eight only are known by their stems and branches; all the others are described from the size of the seeds and the disposition of their spiral lines. Of the whole number, one species only is known from the Wealden or Upper Jurassic; none from the Cretaceous. The other species have been recognized from the different stages of the Tertiary.

MUSCI.

One species of Moss only has been discovered in a fossil state in the Lower Lignitic of the West, while more than twenty-five have been described by European paleontologists, all from the Tertiary measures. At the present epoch, most of the Mosses, growing in the water, upon the ground, the rocks, and the trees, are easily decomposed and destroyed, naturally destined as they are to the formation of humus, and, when upon trees, to the absorption of humidity, either as protection to the roots or as a more active agent of decomposition of the wood. Most of the hard, woody species of mosses live upon the peat-bogs and enter into their composition for the production of the combustible matter. Their discovery in this case is out of question, for

we do not find in the lignite coal any identifiable remains of the plants. It is only when these hard species of Mosses are casually deposited in mud or clay, or buried into sand-banks, that their forms are preserved for an indefinite length of time. The species described below appear to have been imbedded in that way along the muddy borders of a shallow lake. Of the European fossil species, all those referable to the division of the *Acrocarpi* have been found in the Succin by Goeppert; the others, all *Pleurocarpi*, especially referable to the genus *Hypnum*, have been discovered in layers of clay or in beds of sandy shale.

HYPNUM, Linn.

Hypnum Haydenii, Lesqx

Plate V, Figs. 14–14 *b*.

Hypnum Haydenii, Lesqx., Annual Report, 1874, p. 309.

Stem rigid, sparingly divided in nearly opposite, subalternate, short branches, slightly inflated toward the top, or club-shaped; leaves closely imbricated all around the stem and branches, ovate-lanceolate, acuminate, concave.

The specimen is figured as far as it is discernible. The fragment resembles a branch of a coarse species of *Hypnum*, like *H. rugosum*, *H. Boscii*, especially, a species which has its largest branches divided as in this fossil Moss, and of equal size. The mode of division of this plant separates it from the Lycopods, while the apparently thick leaves seem abnormal for a species of Moss. It is well to remark, however, that the matrix wherein the fragment is preserved is a hardened plastic clay, of very fine texture, where even delicate small feathers, wings of insects, etc., are distinctly recognized, and that, therefore, the form of the leaves of a hard species of Moss, even their convexity, may have been easily impressed upon that kind of soft substance. No trace of middle vein is visible, of course, for the species of *Hypnum* have rarely the nerve prominent enough upon the back of the leaves to leave an impression by compression and fossilization. The point is very acute and apparently piliferous, but this last character is not positively ascertained.

HABITAT.—South Park, Colorado, near Castello's Ranch (*Dr. F. V. Hayden*).

LYCOPODIACEÆ.

Species of this family represent an important part of the vegetation of the old coal-measures, not only by large trees, *Lepidodendron*, *Ulodendron*, and other allied genera, but by true species of *Selaginella* and *Lycopodium*, known by their

branches, leaves, and fructifications. Three species of the first group and as many of the second have been published by Goldenberg from the Upper Carboniferous flora of Saarbruck in Alsatia, besides others, less distinct, known as *Lycopodites*, also from the Carboniferous, even the Devonian. From the Coal epoch to the present time, however, this family was until now represented by a single species, *Lycopodites falcatus*, L. & H., apparently a *Selaginella*, from the Oölite of England. Even among the thousands of Tertiary species described by European authors, no plant of this kind is mentioned. This is a remarkable fact, as the Lycopods especially thrive at our time under the shade of Conifers, and as the Permian, the Jurassic, especially, have in their flora, as far as it is known, a large preponderance of species of this kind. The discovery of two or three species of *Selaginella* and a *Lycopodium* in our Lignitic flora is, therefore, truly remarkable; and it is especially fortunate that *Selaginella* at least is represented by a number of so well preserved specimens that the characters cannot be mistaken. The genus is mostly tropical or equatorial; its species, especially numerous in Brazil, cover the ground under the shade of Palm trees. An association of this kind is remarked at Golden, where the remains of Palm trunks and leaves are found in profusion.

LYCOPODIUM, Linn., Spring.

Lycopodium prominens, Lesqx.

Plate V, Figs. 13–13 *b*.

Lycopodium prominens, Lesqx., Annual Report, 1873, p. 409.

Stems or branches dichotomous; divisions short, slender, erect or half open, distant; leaves alternate or disposed in spiral order, cylindrical, inflated, and obtusely pointed, apparently connate at the narrowed base, half open, like the branches, slightly curved backward.

The fragment of frond representing this species is half imbedded into the stone, or covered by a thin concretionary compound, the branches and leaves being in relief upon the surface. The slender divisions, of the same size as the main axis, vary in length and in degree of divergence. The leaves, three to four millimeters long, half a millimeter wide, are loosely imbricated, open-erect, inflated toward the point or club-shaped, obtuse or acute, some of them curved outside. As seen in fig. 13 *b*, no trace of a middle nerve is recognizable upon them, even with a strong glass; but this may be due to the thin crust of clayey matter which covers the whole plant. There is upon the same specimen an obscure fragment, which appears to

represent a cylindrical ear of *Lycopodium*, which may be a fruiting branch of this species. It is two centimeters long, three millimeters wide, and seems to bear small round glomerules, like crushed sporanges of Lycopods. These are, however, too indefinite in form, and could not be satisfactorily represented.

HABITAT.—Near Elko Station, Utah (*Prof. E. D. Cope*).

SELAGINELLA, Beauv., Spring.

Selaginella Berthoudi, Lesqx.

Plate V, Figs. 12, 12 *a*.

Selaginella Berthoudi, Lesqx., Annual Report, 1873, p. 395.

Frond dichotomous like the stems and branches, prostrate or creeping (?), slender; divisions linear, at an acute angle of divergence, short; leaves four-ranked, lateral ones spreading, distichous, linear, oblong or lanceolate, pointed; middle leaves small, oval or nearly round, entire, closely appressed to the base of the longer leaves and covering it.

This fine species, represented by very distinct specimens, seems to have had, like many analogous species of the present flora, a large, diffuse frond, either creeping or flattened upon the ground. All its divisions are dichotomous and apparently on the same acute angle of divergence of 40° to 50°; the ultimate ones are short, linear, obtuse or truncate, one to two centimeters long, four millimeters wide. The leaves are in two rows, the lateral ones open distichous, imbricated by the lower side, longer, oblong, lanceolate-acute, sessile, and distinctly nerved in the middle; the intermediate ones, much smaller, scarcely one millimeter long and half as broad, are of about the same form, oval, obtusely pointed, and marked also by a middle nerve. All the leaves are entire, alternate, and thickish, not pellucid, their surface being generally covered by a thin pellicle of coaly matter. This plant, in its charter, greatly resembles some of the present species of this genus inhabiting subtropical regions, like *S. stolonifera*, *S. Mertensii*, etc.

HABITAT.—Golden, Colorado (*Capt. Ed. Berthoud*), to whom this fine species is justly dedicated.

Selaginella falcata, Lesqx.

Plate LXI, Figs. 12–15; Plate LXIV, Figs. 13, 13 *a*.

Selaginella falcata, Lesqx., Annual Report, 1874, p. 297.

Primary stem thick, round, dichotomous; pinnæ narrow, linear; leaves close, two-ranked, distichous, sessile, open, generally covering each other at the borders, entire, lanceolate-pointed, narrowed at their point of attachment to a slender rachis, membranaceous, pellucid, without any middle nerve.

Though the stem, plate lxiv, fig. 13, was not found connected with any fragment of branches, the leaves which cover it all around, imbricating at

the base, but generally directed toward both sides, are so exactly of the same character as those of the branches of plate lxi, figs. 12 and 14, that one can but consider these fragments as representing the same kind of vegetable, its stem and some of its divisions. The branches are slender, variable in length, from one to three centimeters long, linear, five to ten millimeters broad, with a very narrow rachis; the leaves distichous, nearly at right angles to the rachis, are narrowed to the base, lanceolate-pointed, and slightly falcate, generally close to each other, and often imbricating at the borders, without trace of middle nerve; the substance is membranaceous and pellucid, of straw color. As seen in fig. 15, some of the branches seem to come in fascicles out of fragments which appear half decomposed, perhaps the bark of the stem stem or a casual agglomeration.

The characters of this remarkable plant do not fully correspond to those of *Selaginella*. Its divisions are not distinctly dichotomous, as seen in figs. 12 and 13 of plate lxi, and the leaves are without trace of a middle nerve. The form and position of the leaves might suggest its reference to some peculiar species of Conifers, but the membranaceous pellucid leaves, without middle nerve, as well as the very slender rachis, are against a reference of this kind. It might perhaps represent some peculiar new type of floating Fern. The fragments are very numerous, perfectly distinct; the characters of the plant are exactly represented by the figures.

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden*, *Wm. Cleburn*).

Selaginella laciniata, Lesqx.

Plate LXIV, Figs. 12, 12*a*.

Selaginella laciniata, Lesqx., Annual Report, 1874, p. 297.

Branches and subdivisions like those of the former species, leaves(?) deeply laciniate; lacinæi linear, slightly inflated toward the point, either simple from the base or dichotomous.

By their mode of vegetation and the form and division of the pinnæ or branchlets, these plants are exactly similar to those described above, and indeed they seem to represent the same species under different forms. The difference is in the laceration or thread-like laciniæ of the leaflets. These laciniæ, distinct and in relief upon the stone, resemble the veins of Fern leaves, when, by maceration and decomposition, the epidermis has been destroyed, and the skeleton of the leaves only is left. In this case, the thread-like branches are not equally and normally divided like veinlets, but, as

seen in fig. 12 *a*, enlarged, they are either simple from the point of attachment or forked once or twice, slightly tumescent at the point. Their distribution in bundles along an axis is perhaps more analogous to that of rootlets of creeping rhizomas, and the presence of thread-like filaments of this kind upon the left branch of the specimen, plate lxi, fig. 15, evidently part of *Selaginella falcata*, might confirm this supposition; but there is no great analogy between the characters of thread-like rootlets and those of this plant, for these are too regular in their form, their divisions, and their curve in the same direction. It may be that we have here, and in these two plants, the submerged and the floating part of the same species; that as it happens in some Phænogamous plants of the present flora, as, for example, in *Nasturtium lacustre*, the immersed leaves are laciniate while the emerged ones are entire. I have, however, vainly searched among species of *Lycopodiaceæ* of our time for any traces of abnormal divisions like these; even *Lycopodium inundatum* has the leaves of the immersed branches entire. On another side, some creeping species of *Selaginella* have at the base of the stems, or upon the stolons, a kind of tendrils, generally filiform, sometimes dichotomous, divided toward the ends, and the divisions slightly inflated. This character is marked in *Selaginella Mertensii*, *S. apus*, but more distinctly in *S. microphylla* of Cuba, whose tendrils are shorter and sometimes subdivided at the end in six or eight branches. From this it appears that these two forms described above may be parts of a species of creeping *Selaginella*, the stem, stolons, and tendrils being represented on plate lxiv, figs. 12, 13, the branches and leaves on plate lxi, figs. 12–15. The specimens figured upon this last plate are all from Dr. Hayden, and, though very numerous, none of them has any trace of these laciniate divisions, except the small branchlet, fig. 15, where the thread-like filaments are simple, short, and apparently representing the base and remnants of leaves destroyed by maceration, an appearance also less definitely marked upon the lower branches of fig. 13: *per contra*, the specimens sent by Mr. Cleburn from the same locality have only the part of stem, plate lxiv, fig. 13, and very numerous fragments of the form, fig. 12, but no branch with leaves like those described as *Selaginella falcata*. For this reason, and that of doubtful identity, they have been described and figured separately.

HABITAT.—Point of Rocks, Wyoming (*Wm. Cleburn*).

FILICES.

The Ferns are, after the *Lycopodiaceæ*, the oldest vegetables of the world. From the Devonian, where already a number of species of peculiar types are known, they become more and more numerous and predominant up to the end of the Carboniferous; for, in this formation, they compose at least one-half of the vegetation. After this, in the Permian, the Trias, the Jurassic, and the Cretaceous, they are subordinate in number to the other groups of plants, represented, however, in constantly modified characters appropriate and particular to the different epochs. The *Gleicheniæ*, for example, appear in the Jurassic, become predominant through the whole Cretaceous formation, wherein a comparatively large number of species has been observed in the Arctic zone, in Europe, and also in the Dakota group of Nebraska. In the Tertiary, they disappear most entirely, and therefore it is not at all surprising that among the numerous species of Ferns described from the Lignitic there is no *Gleichenia.* This absence of a genus truly Cretaceous and generally distributed through this formation, present also in the Dakota group, is, among others, an important point of evidence of the Tertiary age of the Lower Lignitic flora.

SPHENOPTERIS, Brgt.

Sphenopteris Lakesii, Lesqx.

Plate II, Figs. 1–1 *a*.

Sphenopteris Eocenica, Ett., Eoc. Fl. d. M. Prom., p. 9, pl. ii, figs. 5–8.—Lesqx., Annual Report, 1872, p. 376.

Frond large, at least tripinnately divided; secondary pinnæ long, linear-lanceolate, oblique to a half-round, narrow rachis; pinnules obliquely turned upward, close, contiguous, and united below the middle, acutely lobed; veins pinnate; divisions simple or forking once.

As remarked in the first description of this species, it differs evidently from the one described under this last name by d'Ettingshausen (*loc. cit.*) by the connection of the pinnules from below the middle, while they are separated from the base in the European species; by the sharply pointed lobes of the pinnules, described and figured as obtuse by the author, and also by the nervation. In this species, the secondary veins are strong, flat, generally simple, each of the divisions ascending to the point of a lobe. These differences are marked enough to force the separation of this species. From the fragments seen of this fine Fern, it has the same characters in all the subdivisions of its fronds; at least the secondary pinnæ are sessile, connected at

their base like the pinnules, and these are cut in more or less deep lobes, also of the same pointed form. The mode of division of the secondary pinnæ is seen in fig. 1 *a*. These are larger toward the base of the frond, and their pinnules are pinnately, acutely lobed; farther up, the pinnæ are simply lobed, like the pinnules. This fine Fern has also an evident relation to *Asplenium Wegmanni*, Brgt., of the *Sézanne Flora*, by Saporta, p. 317, pl. 2, figs. 2 and 3; a species described also by Watelet in the *Flore Foss. du Bassin de Paris*, an Eocene formation like Sézanne.

HABITAT.—Golden, Colorado, where it is often found, but rarely in fragments as large as the specimen figured and communicated by *Rev. Arthur Lakes*, of the School of Mines of Colorado.

Sphenopteris membranacea, Lesqx.

Plate II, Figs. 2, 2 *a*, 3, 3 *a*.

Sphenopteris membranacea, Lesqx., Annual Report, 1873, p. 394.

Frond bi-tripinnate; primary pinnæ long, linear-lanceolate, rigid, erect or at an acute angle of divergence from the main rachis; pinnules narrow, linear-lanceolate, connected near the rachis by the decurrent base, pinnately 5–6-lobed; lobes short, slightly obtuse, distinct, single-nerved.

This form has nearly the same characters as the preceding, and may be a variety of it. Its facies is, however, very different, as seen from its membranaceous shining substance, its rigid divisions, the narrower pinnules, all separated to near the base, by which they are decurrent along the rachis, and generally close to it, forming a narrow border. The slightly obtuse lobes and the narrow pinnules give to this Fern a likeness still more marked to that of the Mount Promina flora. It seems, however, to differ by its membranaceous substance, and by the veinlets, always simple, while they are described by d'Ettingshausen as forking in his species. The affinity is, however, evidently very close. Fig. 2 *a* is from a fragment representing the same species, with pinnules less deeply divided, and which seems intermediate between both forms. The substance is also shining and membranaceous. A small fragment, represented in figs. 3 and 3 *a*, has been merely mentioned in Rep., 1869, p. 196, under the name of *Lustrea arguta?*, with the remark that it might be a *Pecopteris*. It is evidently referable to this or the former species.

HABITAT.—Golden, same locality as the former. The last fragment was in the first lot of specimens sent to me from the collection of *Dr. J. L. Le Conte*, of Philadelphia. The other specimens have been obtained by *Rev. A. Lakes*.

Sphenopteris nigricans, Lesqx.

Plate II, Figs. 4–5 *a*.

Sphenopteris nigricans, Lesqx., Annual Report, 1873, p. 394.

Frond polypinnate; primary pinnæ narrow, linear (as much as can be seen from the fragment); tertiary pinnæ at a right angle of divergence from a slightly winged rachis, short, sessile, linear, abruptly rounded to a small, obtuse, terminal lobe; pinnately deeply lobed; pinnules in right angle to the rachis, distinct to near their base, oblong, obtuse, deeply undulate on the borders; middle vein scarcely distinct, alternately pinnately divided in four to six pairs of veinlets, curving in passing to the borders, forking once, except the upper pair, which is simple.

The specimens are mere fragments; the largest part (fig. 4) shows what appears to be the middle of a pinna of second order, with alternate short divisions two and a half centimeters long or a little more, one centimeter broad, in right angle to the rachis, or very open, deeply undulate on the borders. The surface was apparently covered with a coating of short hairs, as it is punctulate and always colored black. I do not know any recent species of Ferns to which this one is comparable; its nervation is like that of some *Cyatheæ*. Except for its deeply undulate lobes, it is like *Pteris blechnoides*, Heer, Flor. Tert. Helvet., p. 40, pl. xii, fig. 8.

HABITAT.—Golden and Black Butte; always found in small fragments.

HYMENOPHYLLUM, Klf.

Hymenophyllum confusum, Lesqx.

Plate II, Figs. 6–6 *a*.

Hymenophyllum confusum, Lesqx., Annual Report, 1873, p. 395.

Frond polypinnate; primary rachis thick, grooved; ultimate pinnæ lanceolate, deltoid in outline; pinnules simple or bifid, cuneiform, enlarged upward from a decurring base, lobed; lobes short, oblong, obtuse, simple, bifid or emarginate; veins dichotomous; branches simple, each entering one of the divisions of the pinnules.

The description is made from fragments, the species being represented only by crushed parts of the frond mixed together and pressed upon another in a confused mass. The largest portion discernible is the one figured. The primary rachis is not represented, the fragments being too small, and irregularly crushed; the pinnæ are apparently broadly lanceolate, divided to a distance from the rachis in pinnules, cuneate to their decurrent base, enlarged and curved backward at the upper part, either simple and lobed or cut in two divisions, as in the lower part of fig. 6. The lobes are either simple, oblong, obtuse, or enlarged, and emarginate at the upper part into two equal, half-round obtuse divisions; the veins, simple and decurrent to the rachis, at the base of the pinnules are dichotomous in ascending each of the ultimate divisions, reaching the borders of one of the lobes, as seen in fig. 6 *a*. When looked

at with a strong glass, the surface appears minutely punctulate, as if it had been covered by a kind of soft villosity.

By the shape of its pinnules, decurrent upon the rachis, their divisions and nervation, this Fern evidently resembles some of the living species of *Hymenophyllum*. But it is as yet too indistinctly represented to offer positive points of comparison.

HABITAT.—Golden, same place as the former species.

PTERIS, L.

Pteris pseudopennæformis, Lesqx.

Plate IV, Figs. 3, 4.

Pteris pennæformis, Heer, Fl. Tert. Helv., p. 38, pl. xii, fig. 1.—Lesqx., Annual Report, 1873, p. 392.

Pinnæ linear-lanceolate, gradually narrowed upward, entire to above the middle, obtusely dentate at and near the point, subcoriaceous; middle nerve thick, bi-grooved, and three-striated toward the base; veins in an acute angle of divergence, close, thin, mostly simple or forking once.

The fragments representing this species, and of which the best ones have been figured, seem referable to the Miocene form described by Heer. The form of the leaflets is the same; they are also crenulate-dentate toward the point, and the veins, at the same acute angle of divergence, are, as in the European species, either simple or forking once. There is, however, a difference in the more obtuse denticulations, which the author describes as somewhat sharp (*ziemlich scharf*), and especially in the veins, which appear more numerous and close in the American form.

A comparison of specimens only could determine either identity or a specific difference between the European and American forms.

HABITAT.—Henry's Fork (*Dr. F. V. Hayden*).

Pteris subsimplex, Lesqx.

Plate IV, Figs. 5-7.

Pteris subsimplex, Lesqx., Annual Report, 1873, p. 392.

Fronds or pinnæ coriaceous, large, entire or minutely crenulate, ovate-lanceolate, gradually narrowed in a curve to the base; middle nerve narrow, deep; veins at an open angle of divergence, distinct and distant, simple, or merely forking once near their base or toward the middle.

The fragments of this Fern represent either simple fronds or some separate pinnæ of a large frond. They are ovate-lanceolate, tapering gradually to a point (broken), and narrowed in a curve to the base. As seen in fig. 6, the fragment is slightly unequilateral at its base, and thus resembles a pinna rather than a frond; the part in fig. 5 also is different in shape and size, as

would be a terminal pinna. It seems, therefore, that these fragments are mere leaflets. They are in size from eight to ten centimeters long, and from one and a half to three centimeters broad, with a narrow midrib, and thick, distinct veins, all under the same angle of divergence, 60°, simple or forking once, and reaching the borders straight, or without deflecting upward or downward. The borders, by contraction at the point of connection of the veins, are slightly crenulate. This character is unlike that of the nervation of *Osmunda* leaves, to which this Fern might be compared, by the form of the leaflets, resembling those of plate iv, fig. 1. Taken for simple fronds, they have a relation to *Acrostichum latifolium*, Sw., var. *alismæfolium* of Cuba, which has the same type of nervation. As leaflets of a compound frond, they are comparable to *Acrostichum cervinum*, Sw., or *Lomariopsis Wrightii*, Mett., both Cuban species also.

HABITAT.—Golden, Colorado.

Pteris erosa, Lesqx.

Plate IV, Fig. 8.

Pteris erosa, Lesqx., Supplement to Annual Report, 1871, p. 12; Annual Report, 1873, p. 392.

Pinnæ large, broadly lanceolate, taper-pointed; border obtusely dentate toward the point, irregularly crenulate-lacerate in the middle; middle nerve thick; veins at an open angle of divergence, forking once or twice, slightly turned up in reaching the borders.

The only specimen of this Fern figured here represents the point of a large pinna, the fragment being five and a half centimeters long and three centimeters broad toward the middle. The pinnæ are near the point regularly obtusely dentate; but lower the teeth become irregular in form and size, and more or less deeply eroded. The veins are about at the same angle of divergence as in the former species, to which this one has a close relation; they differ, however, by more numerous divisions, and especially by their disposition to slightly curve up in reaching the borders. By this character, the species is allied to *Pteris parschlugiana*, Heer, Bornst. Fl., p. 7, pl. 1, fig. 1, which has the veins divided about in the same way.

Lately, after the printing of the plate and the preparation of the description, I have received from *Rev. A. Lakes*, and found at Golden, a splendid specimen, with one leaflet preserved in its integrity. It is seventeen centimeters long, three and a half centimeters broad below the middle, linear-oblong, rapidly narrowed near the point to an acumen, sharply, nearly equally dentate from a little above the base, which is unequilateral, rounded on one side, cuneate on the other, broken near the point of attachment, where it is narrowed

to a short pedicel half a centimeter broad. This basilar conformation shows it to be a leaflet of a very large pinna.

Habitat.—Raton Mountains, near Trinidad, New Mexico; Golden, Colorado, where it is not rare, mostly found in fragments. The figured specimen is from this last locality.

WOODWARDIA, Sm.

Woodwardia latiloba, Lesqx.

Plate III, Fig. 1, 1 *a*.

Woodwardia latiloba, Lesqx., Annual Report, 1873, p. 391.

Frond large, bipinnatifid; pinnæ opposite, decurring along the round rachis, long, linear, gradually tapering to the point, equally pinnately lobed; lobes disjointed to three-fourths of their length, broadly lanceolate, obtusely pointed, scythe-shaped upward; middle nerve thick, distinct to the point of the lobes; secondary veins parallel to the rachis and the midrib, branching upward; areolation formed by anastomoses of the divisions in one or two rows of large, irregular meshes; ultimate veinlets parallel, passing up obliquely to the borders.

From the fine specimen figured, the upper part of a large pinna, the fronds appear to have been long, linear, very gradually diminishing upward; secondary pinnæ also comparatively long, twenty-one to twenty-four centimeters at least, linear, slightly broader in the middle, and gradually narrowed to the point, three and one-half to four centimeters broad; lobes equal, disjoined to three-fourths of their length, entire or slightly crenulate, broadly lanceolate, obtusely pointed, with narrow obtuse sinuses between them, subfalcate, six to seven millimeters broad; upper pinnæ more and more obtusely and less deeply lobed, passing to mere equal undulations; middle nerve thick, ascending to the point of the lobes; areolation discernible only on the lower surface. As seen in fig. 1 *a*, the lower secondary veins follow parallel to the rachis, branching upward, and forming one or two rows of large rectangular areolæ with branchlets, either simple and parallel, or forking near the point and entering the borders. The consistence of this Fern is thick, coriaceous; the upper surface smooth, nearly polished. The fructifications are as yet unknown.

Habitat.—Golden, Colorado; found in numerous large fragments, and communicated by *Rev. A. Lakes.*

Woodwardia latiloba var. minor, Lesqx.

Plate IV, Figs. 9, 9 *a*.

Woodwardia latiloba var. *minor*, Lesqx., Annual Report, 1873, p. 391.

Pinnæ small; rachis narrow; lobes short, obtuse; secondary veins less divided.

This small fragment appears to represent a mere variety of the species

described from Golden. As it represents only the end of a pinna, the lobes are of course shorter and more obtuse; the subdivision of the secondary veins is less multiplied, forming a single row of basilar areas and the veins generally merely forking. This difference in that nervation is also probably due to the position of the fragment relatively to the frond. This form is related to *Woodwardites arcticus*, Heer, Flor. Arct., ii, p. 462, pl. xl, fig. 6.

HABITAT.—Black Butte, Wyoming. Days of researches at the same locality failed to procure any other specimen than the fragment figured.

Diplazium Muelleri? Heer.

Plate IV, Figs. 10, 10 *a*.

Diplazium Muelleri, Heer, Bornst. Flor., p. 8, plate i, fig. 2.—Lesqx., Annual Report, 1873, p. 393.

Pinnæ coriaceous, simple, narrowly lanceolate, gradually tapering to a long acumen; borders margined, distantly, equally, sharply serrate; middle nerve broad, grooved; veins at an acute angle of divergence, very close, dichotomous, and anastomosing in right angle by cross-veinlets.

This Fern, as represented by the only fragment figured, is remarkable by its thick substance, truly coriaceous, and its inflated, cartilaginous, sharply serrate margin. By the form of the pinna and its dentate borders, it is evidently related to Heer's species. It is, however, different by the nervation, the veins being more divided and distinctly anastomosing. As the coriaceous texture of this leaf does not allow to see clearly the disposition of the lateral veins, and especially the anastomoses, which are visible only in some parts where the epidermis is destroyed, it might be supposed that the European specimens, in a better state of preservation, did not expose all the details of nervation as they are seen upon the fragment, fig. 10 *a*, a part of fig. 10, where the epidermis is erased. Heer mentions the leathery texture and peculiar dentate borders, which in his leaf are doubly dentate, and therefore less regular than in this fragment. Though it may be of the relation of these forms, the nervation with its anastomoses seems to remove the American species from the genus *Diplazium*. It has some analogy with species of *Acrostichum*, *A. alismæfolium*, for the thick border, and *A. aureum*, for the close anastomosing veins; but this is a distant relation indeed. It might be compared also to some species of *Aneimia*.

HABITAT.—Henry's Fork (*Dr. F. V. Hayden*).

LASTREA, Presl.

Lastrea (Goniopteris) Goldiana, Lesqx.

Plate IV, Fig. 13.

Aspidium Goldianum, Lesqx., Annual Report, 1873, p. 393.

Frond bi-tripinnatifid; primary pinnæ broadly deltoid in outline; secondary pinnæ linear, alternate, parallel, at an obtuse angle of divergence, alternately and equally pinnately lobed; lobes cut to two-thirds or three-fourths of their length, oblong-lanceolate, obtusely pointed, inclined outside; middle nerve distinct; lateral veins five to seven pairs, curving inward, simple, parallel; borders slightly crenulate by the impressions of the veins.

The substance of this Fern is somewhat thick or subcoriaceous; the secondary pinnæ, apparently long and rapidly decreasing toward the point of the pinnæ, are sessile, the inferior lower leaflet being free or not decurrent along the rachis; the lobes are really entire as far as can be seen from the recurved borders, and the crenulation is an appearance caused by the impression of the veins; the rachis, both of the primary and secondary pinnæ, is narrow, smooth. Its affinity is with a number of species of Cuba, like *Lastrea contermina*, Desv., *L. lonchodes*, H. K., and especially *L. scolopendroides*, Mett., var. *pinnata*. In the fossil species, its relation is with *L. serrulata*, Heer, of the Boernstadt flora, differing widely, however, by the nearly entire borders, and the lateral veins more numerous and at a more open angle of divergence.

To this species are apparently referable a number of fragments representing mere parts of pinnæ, with pinnules slightly longer than those of fig. 13, but of the same form and with the same nervation. One of the specimens has a small part of a fructified pinna, the leaflets bearing small round *sori* attached upon the middle of the simple veinlets at equal distance of the borders and the midrib, as in species of *Goniopteris*.

HABITAT.—Golden, Colorado. The fragments with fructifications have been lately procured by *Rev. A. Lakes.*

Lastrea (Goniopteris) intermedia, Lesqx.

Plate IV, Fig. 14.

Aspidium (*Lastrea*) *pulchellum* ? or *A. Fischeri* ?, Lesqx., Annual Report, 1870, p. 384.

Frond pinnate; pinnæ linear, oblique, alternate, connected by the decurrent base, pinnately equally lobed; lobes divided to near the base, oblong, obtuse, oblique; lateral veins simple, curved upward.

The specimen represents part of an apparently large pinna; the divisions are short, linear, one to two centimeters broad, rapidly narrowing toward the top of the frond, parallel, at an acute angle of divergence, 30°, and decurring

along the rachis by the expansion of the lower leaflets; the lobes turned upward are oblong, narrowed into an obtuse point, alternate, free to below the middle; the middle nerve is strong, continuous to the point; the lateral veins simple, five or six pairs, open, and curving upward in passing to the borders. Comparing this species to both *Lastrea pulchella* and *L. Fischeri*, Heer (Flor. Tert. Helvet., I, pp. 33 and 34, pl. ix, figs. 2 and 3), the close relation of this fragment is easily remarked, the form of the lobes being analogous to that of fig. 2, and the disposition of the veins, which are more numerous, like that of fig. 3 of the Flor. Tert. There is, however, a difference, which prevents considering the American form as identical with these European species; it is the evident connection of the pinnæ by the lower and inferior pinnules, broadly extending and decurrent by their base along the main rachis, a character marked only, and indistinctly, upon *L. pulchella*, fig. 2 *c* of the same plate. It seems, therefore, advisable to consider this species as separate. The specimens briefly described in Report, 1870, were mere scattered fragments of pinnæ, none of them showing the mode of attachment to the rachis. This form is also comparable to *Alsophila Pomelii*, Sap. (Séz. Fl., p. 40, pl. 3, fig. 2).

HABITAT.—The specimens described in Annual Report, 1870, are from Henry's Fork, a mixed lot; the first one sent by *Prof. F. V. Hayden*. That figured here is from Golden, Colorado.

Lastrea (Goniopteris) polypodioides?, Ett.

Plate IV, Figs. 11, 12.

Goniopteris polypodioides, Ett., Flor. of Prom., p. 10, pl. ii, figs. 1-4.—Lesqx., Annual Report, 1873, p. 394.

Pinnæ large, linear-lanceolate, pointed, undulately lobed, indistinctly denticulate; primary veins equidistant, parallel; lateral veins at an acute angle of divergence, apparently alternate, simple, and curved inward.

The fragments figured here, and described as probably representing the species of d'Ettingshausen, are too obscure for positive identification. The divisions, or lobes, are scarcely marked by undulations along the pinnæ, and also the distant, irregular, small teeth are not distinctly seen, the borders appearing here and there like serrulate. The nervation is of the same type, and quite as obscure as it appears to be on the European specimens. Judging from the figures of the *Prom. Fl.*, there is therefore a marked relation between the species, but the identity is doubtful.

HABITAT.—Sand Creek, Colorado (*W. H. Holmes*).

GYMNOGRAMMA, Desv.

Gymnogramma Gardneri, Lesqx.

Plate IV, Fig. 2.

Pteris Gardneri, Lesqx., Annual Report, 1873, p. 393.

Frond large, simply pinnate; pinnæ large, linear, broader in the middle, in right angle to the rachis, rounded to the base; borders deeply undulate; middle nerve broad, grooved in the middle, flattened on the borders; veins in an obtuse angle of divergence, abruptly curving downward at the base, or decurring to the rachis, forking once or twice, joined by anastomoses and forming by cross-branches irregular, long areolæ.

The large pinnæ, three to three and a half centimeters broad in the middle, where they are enlarged and broken, apparently lanceolate, with a broad flat midrib, narrowly grooved in the middle, have entire but irregularly undulate borders, and lateral veins at an open angle of divergence 70 to 80°, thin, forking once near the base, sometimes twice, and here and there irregularly anastomosing by cross-veinlets. The substance is rather thin. I considered first this Fern as referable to *Pteris*, as some species of this genus have pinnæ of the same form, and the lateral veins sometimes anastomosing as in *Pteris grandifolia*, Linn., which, however, shows this kind of division of the veins only near the borders, and far more regular than in this species. The genus *Pteris* has now two essential divisions: *Heterophlebium* and *Campteria;* the first one has leaflets with lateral veins anastomosing toward the margins, the second with veins connected at the base by arching veinlets. I supposed that the fragments described here might represent a section intermediate between both, or with veins anastomosing in the middle of the areas. But there is in *Gymnogramma* a species, *G. Japonica*, Desv., whose characters are so evidently comparable to those of this fossil one that it seems rational to admit it in the same genus. The Japan Fern has long, simple, linear, oblong, acuminate pinnæ, rounded at the base, the rachis flat on both sides of the midrib, the veins close, forking once or twice, and joined by cross-veinlets; all this as in the fossil species. The comparison of specimens shows the relation to be very close.

Count Saporta informs me that quite recently a Fern has been discovered in the Gypses of Aix, representing a species which he considers as identical with this, or at least closely allied. He is disposed to refer it to the genus *Chrysodium*, a section of the *Acrostichum*.

Habitat.—Roof of a coal-mine, Sand Creek, Colorado (*A. Gardner*).

Gymnogramma Haydenii, Lesqx.

Plate V, Figs. 1–3.

Gymnogramma Haydenii, Lesqx., Annual Report, 1871, p. 295.

Frond bi-tripinnatifid; pinnæ long, lanceolate, obtusely pointed, pinnately divided to near the rachis in oblong-lanceolate, obtusely pointed lobes; the lower ones distantly dentate, the upper ones more or less distinctly crenate; rachis narrow; middle nerve thin; lateral veins close, at an acute angle of divergence, dichotomous.

The three specimens figured give a tolerably good representation of the form and of the characters of a pinna of this fine species. These pinnæ were evidently very long, gradually tapering to the point, the lobes becoming shorter and proportionally narrower, though distinct, to the base of the obtusely poinfed terminal pinnule. The largest lobes, oblong, linguiform, are distantly dentate, while in ascending, the marginal divisions, gradually effaced, are merely crenate and the upper ones entire; they are joined in acute sinuses a little above the narrow rachis, and slightly decurrent. As the substance of the Fern is thick, coriaceous, the veins, when the epidermis is not destroyed by maceration, are not very distinct, the middle one being often effaced and the division of the lateral veins here and there obsolete. These are thin, nearly straight in passing to the borders at an angle of 30° to 40° from the midrib, join the main rachis between the pinnules, preserve the same direction, and are dichotomous, generally forking twice. The largest lobes, as seen in fig. 2, are six centimeters long, one and a half centimeters broad in the middle, where they are somewhat enlarged. The division of the veins is seen in fig. 2 *a* enlarged. The surface of the pinnæ is covered by particles of what resembles a pulverulent matter hardened into coal. I do not know of any fossil species to which this one might be compared. *Sphenopteris* (*Gymnogramma*) *Blomstrandi*, Heer (Flor. Arct., i, p. 155, pl. xxix, figs. 1–5), has only a distant likeness by the outlines of its lobes, but is totally different by its nervation, etc. This fossil Fern has a higher degree of affinity to *Gymnogramma tartarea*, Desv., a common species of the present flora of Tropical America, especially related to some of the varieties obtained by cultivation.

Habitat.—Divide between the source of Snake River and the southern shores of Yellowstone Lake (*Dr. F. V. Hayden*).

OSMUNDA, Linn.

Osmunda affinis, Lesqx.

Plate IV, Fig. 1.

Pteris affinis, Lesqx., Annual Report, 1873, p. 392.

Frond simply pinnate; pinnæ subcoriaceous, short, oblong-lanceolate, broader in the middle, rapidly decreasing to an obtuse point, gradually narrowed downward, and apparently rounded to the point of attachment; borders entire or irregularly undulate; nervation thin but very distinct; lateral veins open, dichotomous, generally forking twice, distant.

The position of the pinnæ (the middle one seemingly terminal), their size and form, and also the characters of the nervation of this Fern seem to indicate its generic relation with *Osmunda* rather than with *Pteris*. The pinnæ oblong, enlarged in the middle, tapering to a point, about five centimeters long and two centimeters broad, probably represent the three upper leaflets of a frond; this arrangement may be, however, casual, for the upper pinna, which appears to be terminal, though somewhat larger than the others, and of a different shape, has the midrib exactly of the same size. The lateral veins, at an open angle of 50° about, slightly curve from their point of attachment in passing to the borders, generally forking twice, and are very distinct and distant, as in species of *Osmunda*. The rachis is not preserved.

Recently, I have received from Rev. A. Lakes a splendid specimen, representing part of a large pinna with four leaflets, a terminal one, the others alternate, very oblique, joined to a broad rachis, which, in this specimen, as in the one figured, is destroyed by maceration, its place being merely indicated by the position of the leaflets. These are oblong-linear, four centimeters broad, at least sixteen centimeters long, judging from the preserved part of one of the leaflets, which, broken apparently at the middle, measures ten centimeters from the base. The nervation is of the same type as that of the figure, the veins more generally forking quite near the base at the point of attachment to the rachis. The substance is hard, rather coriaceous.

The fragment described in Report, 1872, p. 376, as *Pteris anceps* apparently refers to this species.

HABITAT.—Golden, Colorado; not rare in fragments.

LYGODIUM, Sw.

Lygodium neuropteroides, Lesqx.

Plate V, Figs. 4–7; Plate VI, Fig. 1.

Lygodium neuropteroides, Lesqx., Annual Report, 1870, p. 384; 1871, p. 284.

Pinnules cordate, two to five palmately lobed, divisions oblong or obovate, lanceolate, obtuse; middle nerve thin; lateral veins close, numerous, dichotomous.

This fine species covers by its remains, mostly leaflets, with rhizomas and their divisions, large and numerous specimens of soft-grained yellow clay. Fragments of stems or rachis are rare, even, indeed, it is uncertain if the thinly striated, flat fragments of woody tissue, varying from two to twelve millimeters in width, represent stems or rachis, for they may be merely half-decomposed branches of the rhizomas. The leaflets, narrowed downward to a cordate base, are two to four palmately parted to the middle more generally, sometimes lower; the divisions, oblong, enlarged upward, and very obtuse or linear-lanceolate and obtusely pointed, are four to eight centimeters long, even more, from the base of the leaflets; the lateral ones generally shorter, all obliquely diverging, with more or less obtuse sinuses, are entire or slightly wavy on the borders. The nervation is simple for each division of the leaflets, the middle nerve of each remaining distinct to the base, where it is generally separated from the others by secondary flabellate veins; lateral veins emerging in a very acute angle of divergence, dichotomous, curving in passing to the borders. The lowest veins are forked three to four times, the upper ones only twice, all very close, especially along the borders, where thirty to thirty-three veinlets are marked in one centimeter. The division of the lateral veins is marked in fig. 5 *a*, enlarged; fig. 5 shows the longest of the divisions of a leaflet, which appears only twice lobed. The rhizomas, two and a half centimeters broad, the largest seen, are pinnately divided in numerous alternate branches, six to eight millimeters broad, narrowly striate, subdivided in branchlets about one millimeter wide, covered with very numerous, close radicles, mostly in right angle, of various length, and of the same thickness in their whole length. Whole large slabs are covered with fragments of these rhizomas and of their branches, one of which is represented in pl. vi, fig. 1. Though the connection to the leaflets is not seen anywhere, they evidently belong to the same species, as no remains of any other kind are preserved upon the same specimens

By the division and the form of the pinnules, this species is related to *Lygodium Gaudini*, Heer (Flor. Tert. Helv., i, p. 41, plate xiii, figs. 5–15),

differing greatly, however, by the broader divisions, and the nervation, which is of a far different type. Indeed, I do not know any species of this genus, either fossil or living, whose secondary veins are so close and as many times forking, resembling, by this character, species of *Neuropteris* of the Carboniferous age. The consistence of the leaves is somewhat thick.

HABITAT.—Barrell's Springs, Washakie group (*Dr. F. V. Hayden*). I have not visited the locality and I mark the geological reference of this species as it is indicated upon the labels of the specimens sent to me already in 1870. Most of these specimens have leaflets and rhizomas only of the same *Lygodium*. The others bear, besides this species, fragments of Palm rays and of *Equisetum Haydenii*. The fragments of Palms have double, comparatively broad (four centimeters), distinctly veined rays, the primary veins at very irregular distances, the secondary ones extremely thin, a kind of nervation similar to that of *Flabellaria Zinkeni* or of *Sabal communis*, two species described in the following pages. These fragments are undeterminable, but merit to be mentioned on account of the geological references. As yet, species of Palms have been found in Colorado and Wyoming, only with the Lignitic No. 1. But though they are positively considered as characteristic of the Lower Lignitic, or Lower Eocene, in its separation from the Cretaceous, they may be found in the upper stages. A Sabal, for example, is, in good specimens, with the plants of the Upper Tertiary, or Pliocene, of California. In this case, however, and in the presence of a Fern, type of a subtropical climate, we see a discrepancy in the climatic circumstances indicated by the other species considered as belonging to the same geological horizon, No. 4, whose vegetable forms represent a more temperate zone. It is therefore advisable to consider the reference of this locality to the Washakie group as uncertain until we have more reliable documents in regard to its geological station. The fragments from the same locality, referred to *Cyperus Deucalionis*, Heer, in Rep., 1870, p. 384, though comparable to the species by their nervation, are too obscure to merit consideration.

Lygodium Marvinei, Lesqx.

Plate V, Fig. 8.

Lygodium Marvinei, Lesqx., Annual Report, 1874, p. 309.

Leaflets tripartite?; divisions oblong, narrowed to a point, serrulate toward the point; middle vein thin, very distinct; secondary veins twice forked.

We have only the fragment figured here, too incomplete to give a good

idea of the form and mode of division of the pinnules, but evidently representing a species of this genus. The divisions are short and comparatively broad, oblong, pointed, and distantly serrulate near the point. The secondary veins are on a more open angle than in the former species, diverging about 40° from the middle nerve, more distant, and forking only twice, or even once. This species has no relation to any fossil of the same genus, for no fossil Lygodium has been described as yet with serrate or dentate lobes. In the living Ferns, *Lygodium venustum*, Sw., may be compared to it.

HABITAT.—Top of gypsum series, Grand Eagle Junction (*A. R. Marvine*). This formation is referable to group No. 1.

Lygodium Dentoni, Lesqx.

Plate LXV, Figs. 12, 13.

Lygodium Dentoni, Lesqx., Annual Report, 1874, p. 309.

Leaflets small, tripartite, with short obtuse divisions and broad sinuses; primary veins three, from the base, distinct; secondary veins also very distinct, forking once or twice, close along the borders.

The leaflets, round truncate at the base, rapidly widen upward, and, near the top, are tripalmately divided in short, very obtuse, entire lobes, separated by very broad sinuses; the middle nerves, somewhat thick, are joined at or near the base; the secondary veins, also comparatively thick and very distinct, ascend at an acute angle of divergence, those between the lobes nearly straight upward, the lateral ones more curving, all forking once or twice, and becoming close to each other along the borders. This species is intimately allied to *Lygodium exquisitum*, Sap. (Ét., iii, 2, p. 88, pl. i, fig. 13), of the Gypses of Aix, a species differing by the secondary nervation, more simple, the veins more distant along the borders, and the leaflets merely bifid. This last character is, however, of little importance, for the only specimen figured by the French author bears, on both sides of the leaflets, short obtuse lobes like those of a tripartite or quadripartite pinnule before its full development. In our species, the leaflets are somewhat larger, two to three and one-half centimeters broad between the points of the lateral lobes, which are one and a half to two and a half centimeters long, and as broad as long.

HABITAT.—Green River group, near the mouth of White into Green River, Utah (*Prof. William Denton*).

Lygodium compactum, Lesqx.

Plate V, Fig. 9.

Lygodium compactum, Lesqx., Annual Report, 1869, p. 196.

Pinnule or lobe linear-lanceolate, entire, slightly broader above the base; lateral veins on a very acute angle of divergence, all very close from the base, forking once or twice.

This fragment is scarcely sufficient to indicate the generic relations. By its close lateral veins it might be compared to *Lygodium neuropteroides*, described above. But the veins in this species, though as close to each other, are more straight and less divided. The borders are lacerated on the right side of the leaflet toward the base, and thus it appears to represent a mere lobe of a palmately divided pinnule.

HABITAT.—Marshal's Mine, Colorado (*Dr. F. V. Hayden*).

RHIZOCARPÆ.

This subclass is represented in a fossil state by *Salvinia* and *Pinnularia* only. In the present flora, *Salvinia* has representatives in the boreal Asiatic regions, and also in tropical America. Europe has one species only, *S. natans*, which, according to Pursh, has been found also in a small lake of New York State, but has not been seen until now by any other botanist. Five fossil species have been described from the Miocene of Europe.

SALVINIA, Mich.

Salvinia cyclophylla, Lesqx.

Plate V, Figs. 10, 10 *a*.

Salvinia cyclophylla, Lesqx., Annual Report, 1873, p. 408.

Leaves nearly round, truncate or slightly cordate at the base, very entire; middle nerve thin lateral veins alternate, on a broad angle of divergence; areolæ polygonal.

The leaf, finely preserved, is twenty-one millimetres long, twenty-five millimetres broad, therefore slightly reniform, with a half-round, narrow middle nerve and lateral veins very thin, scarcely thicker than the nervilles, on an open and variable angle of divergence, some of them in right angle to the midrib, and apparently running to the borders; the areolation is irregularly quadrate, polygonal, comparatively small, distinct.

By the form of its leaves, the species is related to *Salvinia Reussii*, Ett. (Bil. Fl., p. 18, pl. ii, fig. 21), which, however, has a different areolation. Our figure shows the secondary veins slightly more distinct than seen upon the specimens, where they are scarcely distinguishable without a glass.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*).

Salvinia Alleni, Lesqx.

Plate V, Fig. 11.

Ophioglossum Alleni, Lesqx., Annual Report, 1872, p. 371.

Leaves oval, rounded in narrowing to the base; lateral veins, none visible; areolæ large, irregularly square or equilateral, inordinately distributed.

Leaf about three and a half centimeters long, twenty-two millimeters broad, of a thin substance, with a thick middle nerve and irregularly quadrate meshes, formed of very distinct black nervilles, the primary ones more or less in right angle to the middle nerve, with oblique, generally parallel veinlets between them. The borders are black, slightly undulating, as if they were formed by a vein coming out of the attenuated base and following them. By its form, its areolation, its size, all its characters, indeed, it is remarkably similar to *Salvinia reticulata,* Heer (Fl. Tert. Helv., iii, p. 156, pl. cxlv, fig. 16). It merely differs by the surface not smooth or polished, indicating a very thin, pellucid leaf; by the areolation not quite as large, all the meshes in the same direction, rather tending upward than downward; by the gradually narrowing curve to the base, which form a regular oval leaf. As in Heer's species, this one has its areas free, without trace of reticulation. It may represent the same species.

HABITAT.—South Park, near Castello's Ranch (*Prof. J. A. Allen*).

Salvinia attenuata, Lesqx.

Plate LXIV, Figs. 14, 14*a*.

Salvinia attenuata, Lesqx., Annual Report, 1874, p. 296.

Leaves small, opposite, joined by a narrowed, short-pediceled base, broadly oval or round, indistinctly reticulated in vertical parallel rows of large quadrate cells, marked in the middle by black spots composed of very small close cells or pores, without trace of a middle nerve.

The species is represented by the two small leaves figured here, one, the largest, exactly round, measuring one centimeter both ways, the other, smaller, ovate, only eight millimeters long and five millimeters broad. The leaves, joined at the base, attenuated to a short pedicel, have no trace of a middle nerve or of a separation in the middle, the surface being composed of large areolæ exactly square, formed by veinlets ascending from the base and diverging, and from parallel veinlets crossing them in right angle from the borders. These secondary veins are indistinct, and the surface of the leaves appears, with the glass, like a small checker-board, with the squares marked in the middle by an obscure spot apparently formed of round pores, or like a very small wart. This species is closely related by its areolation and the

size of the leaves to *Salvinia Mildeana*, Göpp., as described by Heer (Balt. Flor., p. 17, plate iii, figs. 1 and 2), differing by broader, less distinct, areolæ, the absence of a dividing middle nerve or free line, and the base narrowed to a short pedicel. These differences may be due to the unripe state of the plants, perhaps, when imbedded in the matrix where they are preserved. This seems indicated by the smaller size of one of the leaves and the indistinct areolation. *Salvinia natans* of the present flora has its leaves scarcely nerved in the middle before they attain their full development, or rather the middle nerve becomes visible only upon full-grown leaves. The more marked difference is in the form of the base of the leaves, which is cordate in the European species. This character is preserved also in the figures and description of *S. Mildeana*, Ung. (Sill., p. 5, pl. i, figs. 7, 8).

HABITAT.—Point of Rocks (*Wm. Cleburn*).

CALAMARIÆ.

Like the Ferns, this class of plants had its predominance in the Carboniferous period, when it was especially represented by the *Calamites* and *Equisetites*, already present in the Devonian; plants of large size, reaching the dimensions of trees, with trunks sometimes twenty centimeters in diameter. The section of the *Equisetaceæ* has followed after the disappearance of the *Calamites*, from the Keuper to the present time. In the old formations, these plants are still of large size, but from the Tertiary we find the genus as it is now, with species whose stems are rarely more than two centimeters thick. They are about equally distributed from the Triassic upward. This formation has ten species, the Jurassic has eight, the Wealden five; from the Cretaceous, two only are known, and fifteen from the Tertiary. The *Schizoneura*, another genus of this order of plants, is Triassic mostly, one species only being known from the Oölite. *Phillotheka* represents species found in the Oölite of New Holland. Its place seems intermediate between *Calamites* and *Equisetum*.

In the present vegetation of the world, the group of the *Equisetaceæ* has about twenty-five species known until now. They are distributed in Europe, Asia, and the American continent, which has the largest number, twenty-one species, of which nine belong exclusively to its flora.

EQUISETACEÆ.

EQUISETUM, Linn.

Equisetum Haydenii, Lesqx.

Plate VI, Figs. 2–4.

Equisetum Haydenii, Lesqx., Annual Report, 1871, p. 284; 1872, p. 385.

Rhizomas thick, cylindrical, irregularly distinctly striate, articulate; articulations distant, bearing large oval or obovate tubercles narrowed to a round point of attachment, in whorls of eight to ten around the articulations.

The rhizomas, flattened by compression to about two centimetres in width, are regularly cylindrical, slightly narrowed only at the articulations; these are distantly marked around by circular scars at the point of attachment of oval or obovate tubercles, averaging two centimeters in length and one and a half centimeters broad; the rhizomas are distinctly irregularly striate, the tubercles obscurely ribbed in the length, either simple and joined to each other by their ends, like a string of beads, or double, two of them being attached to the inflated end of a single one, as on the right side of fig. 3. At a distance from the point of connection to the rhizomas, and as seen from the numerous fragments of this species covering large slabs, the tubercles become more and more elongated, and pass to mere cylindrical filaments, or rootlets, which appear to divide into radicles. The point of union of the tubercles, either to each other or to the rhizomas, is marked by comparatively large scars, three to four millimeters wide, representing a double ring with a central point. Fig. 4 represents one of these tubercles split lengthwise, and exposing in the middle a central solid axis, one and a half millimeters thick, while the parietes or intervals from the axis to the borders, four millimeters each side, appear formed of a spongy though compact medullar tissue, becoming more compact or darker-colored near the borders. A vertical cross-section of another tubercle from Carbon specimens, like the former, shows it to be oval or somewhat flattened by compression, twelve millimeters in one direction and only nine in the other. Still another specimen of the same locality represents a linear rootlet, or rhizoma, whose main axis, four millimeters wide and central, appears surrounded by a cylinder of cellular tissue of equal thickness. This branch is marked by distant nodi and round scars, the same as those of Barrell's Springs, from which the species was first described. This species is comparable to *Equisetum arcticum*, Heer (Spitz. Flor., p. 31, pl. 1, figs. 1–15), which has narrower rhizomas, with nearly as large tubercles, more elongated and narrower at their point of attachment, and also to *Physagenia* (*Equisetum*) *Parlatorii*, Ung. (Sillog., p. 4, plate 1,

figs. 5, 6), which bears much smaller, more regular tubercles, nearly exactly oval. In both these species, the articulations are inflated; in ours, they are strangled, as seen in the figures.

HABITAT.—Barrell's Springs (*Dr. F. V. Hayden*), Carbon Station, Wyoming. The specimens of this locality are too fragmentary for positively demonstrating specific identity.

Equisetum lævigatum, Lesqx.

Plate VI, Figs. 6, 7.

Equisetum? lævigatum, Lesqx., Annual Report, 1873, p. 395.

Stem or rhizoma thick, distantly and obscurely articulated, irregularly wrinkled in the length; articulations marked by round scars, distant from each other.

The only specimens obtained of this species are figured here. They seem to represent remains of a large species of *Equisetum* by the indistinct articulations and the scars perceivable around them. The large specimen (fig. 7) is only part of a stem or rhizoma divided in its length; the articulation is marked merely by two scars, round in the center, with a row of oval impressions placed starlike around it, as it is sometimes the case in large fossil species of *Equisetum*. It is narrowed above the articulations, and appears enlarged at the nodi, but probably by a compression of the stem, more marked there than it is above; the surface of the specimen is smooth, merely impressed by irregular wrinkles, not true equal striæ. The other smaller specimen (fig. 6) has its articulation marked on one side by a round scar, and on the other by the outside of a scar of the same form, to which is attached an articulated branch, flattened in the middle, then divided in two at its end, either by normal separation or by splitting from mechanical compression. This part resembles somewhat fig. 2 of the same plate, for the branch represents apparently less inflated tubercles, or the division of a rhizoma slightly strangled at the articulations and disfigured by compression. I therefore consider these fragments as representing a species or perhaps two different species of *Equisetum*, the one with a much larger stem and the scars marked by an outside row of oval impressions; the other smaller, differing from *Equisetum Haydenii*, especially by its smooth surface, the less distinct articulations, with more distant round scars, and the irregular form of the tubercles. Characters of this kind, and too indefinite, cannot be considered as specific, perhaps. They are to be carefully considered, however, as the specimens belong to a stage of the Tertiary different from those of the former species.

HABITAT.—The large specimen (fig. 7) is from Sand Creek, Colorado, eight feet above coal (*W. H. Holmes*); the small one from Golden (*A. Lakes*)

Equisetum Wyomingense, Lesqx.

Plate VI, Figs. 8–11.

Equisetum Wyomingense, Lesqx., Annual Report, 1873, p. 409.

Stems or rhizomas equally distinctly striate, articulate; articulations short; sheaths acutely dentate; radicles in bundles from the articulations.

The specimens are large slabs of very hard white shale, covered with a profusion of fragments of the same plants, rootlets, rhizomas, stems crushed, pressed together, and rarely separated distinctly enough to clearly show their characters. The best ones are figured. They represent fragments of stems, or of rhizomas, articulated, slightly narrowed at the articulations, which are close, either naked or marked by round small scars, and bearing bundles of simple rootlets, diverging starlike; all the fragments of stems and rhizomas are equally and regularly striate; the sheaths, as seen in figs. 8 and 9, equally dentate on the borders, and short; fig. 11 is apparently an inflated articulation of a rhizoma or tubercle, bearing at one end a compound branch or rootlet, with a whorl of rootlets in the middle; these rootlets are all of the same size, less than one millimeter thick, linear or filiform, simple or forking, as seen on the lateral branch of fig. 8. The stems and rhizomas, also of equal size, average half a centimeter in width.

HABITAT.—Three miles east of Green River Station, Wyoming Territory.

Equisetum limosum?, Linn.

Plate VI, Fig. 5.

Equisetum limosum, Linn., Annual Report, 1871, p. 299.

Stem simple, deeply striate, articulate; articulations short; sheaths short, acutely dentate.

Though it is not possible to prove identity from a mere fragment of *Equisetum* representing only part of a stem and its sheaths, it is also impossible to find a point of difference in comparing this stem with that of the living *Equisetum limosum*. As in this last species, the stem is equally ten-ribbed or deeply striate, the sheaths of the same length, blackened also in the upper border, with narrow, acutely pointed, equal teeth, appressed upon the stem. It is evidently different from the former species by the more numerous and narrower teeth of the sheath.

HABITAT.—Near Yellowstone Lake, among basaltic rocks. The geological age of the formation is not indicated with the specimens; it may be some recent deposit by hot springs or volcanic agency (*Dr. F. V. Hayden*).

PHÆNOGAMÆ.

GYMNOSPERMÆ.

CYCADINEÆ.

The two essential groups of this family, the *Zamieæ* and the *Cycadeæ*, have at our time a comparatively small number of species distributed in the tropical and subtropical regions of the world. The genus *Zamia* is mostly American, its species inhabiting Mexico, the West Indian Islands, and the mountains of the Pacific coast; one species is found in Florida. Of *Cycas*, no species is indigenous upon the American continent.

In the old geological formation, the *Cycadineæ* were very numerous, especially most abundant in the Trias and the Oölite, which, taken both together, have more than one hundred and sixty species of this order, out of about two hundred, constituting the whole flora of this formation, as known by authors. A number of vegetable remains from the Devonian and the Carboniferous, leaves known under the generic name of *Flabellaria*, *Cordaites*, *Noeggerathia;* and fruits, *Trigonocarpus*, *Rhabdocarpus*, *Cardiocarpus*, etc., are until now of uncertain relation, some of their characters referring these plants to this family, others to the Conifers. Very few *Cycadineæ* are known in formations above the Jurassic. One, *Pteroplyllum*, is described from the Cretaceous of Kansas, and another, closely allied, from that of Germany. This formation has also two Strobiles described as *Zamiostrobus;* a third is known from the Miocene.

ZAMIEÆ.

ZAMIOSTROBUS, Endl.

Zamiostrobus? mirabilis, Lesqx.

Plate LXIII, Figs. 1–1 *d*.

Zamiostrobus mirabilis, Lesqx., Annual Report, 1874, p. 309.

Fragment of a large silicified cone, checkered upon its outer surface by the rhomboidal obtuse top of quadrangular long seeds, black-colored, and apparently of a hard substance, embedded into a white celluloso-vascular matrix, separated from the common cylindrical axis by a zone of the same matter, or fixed upon it by their base.

The specimen represents a fragment only of the cross-section of a large cone, measuring about fourteen centimeters in diameter, and perfectly silicified. As seen in fig. 1, it is composed of a cylindrical axis, *c*, made up of fragments of a dark opaque matter, agglutinated and amorphous, to which are

attached fruits or seeds apparently of hard consistence, represented as they are by a black compact silex, and pierced in the length by pores, or ducts, continuous from the top to the base. These seeds, three to three and a half centimeters long, six to eight millimeters broad, are quadrangular, somewhat flattened, and therefore transversely rhomboidal, as seen from their cross-section in fig. 1. From the outer surface, where the angles are rounded or more obtuse, they pass down, through a white celluloso-vascular substance wherein they are imbedded, to the axis *c*. In fig. 1 *b*, which represents part of the reverse of the same specimen, the seeds appear shorter and separated from the axis *c* by a zone, *b*, of the same whitish substance as that which surrounds them. The intervals are as wide as the space filled by the seeds. This white matter appears, when seen with a strong glass, composed from very thin, parallel, linear filaments descending from the surface to the axis.

Though I do not know any fruit presenting an evident likeness to this remarkable fragment, I believe it referable to some species of *Zamieæ*. By the form and disposition of its surface-scars, it is comparable to species of *Androstrobus*, a genus established by Schimper for the description of cylindrical Cycadeous male cones formed of imbricated scales, bearing sessile anthers upon their lower surface. By the position of the seeds, and also by their form and size, it has a distant relation to *Zamiostrobus gibbus*, Reuss, represented by a cone, which shows, in its section, oblong, obtuse seeds placed at right angles to a cylindrical axis, with the tops appearing at the outside surface. Both these cones are figured in the Atlas of Schimper's Pal. Veget., pl. lxxii, figs. 1, 2, 14, 15. There is, however, a great difference in the large size and in the characters of this silicified Strobile from the species mentioned above.

HABITAT.—Near Golden, Colorado, found by Dr. F. V. Hayden on the surface soil, without connection to any stratum of rock. This, however, does not, positively at least, force its reference to an antecedent formation, as silicified trunks, especially of Palms, and rounded fragments of the same kind, are abundantly found around Golden and in Colorado, together with petrified and silicified trunks of trees still standing and in place. The fragment of this cone has been apparently detached and drifted from the same formation.

CONIFERÆ.

The Conifers appear already in the Devonian, where remains of large trunks have been found and referred from the characters of their internal

structure to species of this family. Fossilized trunks of Conifers have been found also in the Subcarboniferous of England. In the true North American Carboniferous, we have as yet scarcely any trace of Conifers; at least, the remains referred to them, those of the genus *Artisia*, for example, are still of uncertain relation. If the *Cordaites* of the coal have apparently characters which relate them to *Cycadeæ*, the species of *Noeggerathia*, of the same formation, might as legitimately be referred to Conifers. This question is still in a state of uncertainty. Immediately above the Coal-Measures, even in their higher strata, and in the Lower Permian, the Conifers appear in a fair proportion by two new genera, *Walchia* and *Volzia*, which persist into the Trias, with a few *Cypressineæ*. The Jurassic has genera of the *Araucariæ*, the *Abietineæ*, and the *Taxodiæ* essentially predominant, as in the Cretaceous also. But the largest number of Conifers is known in the Tertiary, wherefrom two hundred and twenty-five species or more are described until now. This does not positively indicate what may be the distribution in the other formations, whose flora, comparatively to that of the Tertiary, is scarcely known, except that of the Carboniferous, however, from which fourteen species of Conifers are described in Europe from fossilized wood. Of the genera still present in the flora of our epoch, *Araucaria* appears in the Trias, is more abundant in the Jurassic, and absent from the flora of the Miocene, now inhabits the countries south of the equator, especially New Holland. *Sequoia*, Cretaceous and Miocene, is left in the present flora by the two well-known species of California, *S. sempervirens* and *S. gigantea*. *Pinus*, with a few representatives in the Cretaceous, becomes extremely predominant in the Miocene, from which more than one hundred species are described; while *Larix*, *Cedrus*, *Abies*, and *Taxodium*, which appear at first in the Tertiary, continue to the present time.

CUPRESSINEÆ.

WIDDRINGTONIA, Endl.

Widdringtonia? complanata, Lesqx.

Plate LXII, Figs. 13, 14.

Widdringtonia complanata, Lesqx., Annual Report, 1874, p. 299.

Stem thick, disticho-pinnate; branchlets short, thick, obtuse, alternate, oblique; leaves small, apparently in spiral order, closely imbricate and appressed, oblong, lingulate-pointed upon the primary branches, ovate-pointed or rhomboidal and short upon the branchlets.

This species appears to have been of a soft though thickish substance. All the specimens are flattened, even the branches, and, in that way, the form

and the relative position of the leaves are not satisfactorily distinguishable. The primary branches, more or less flexuous, two to three millimeters thick, are long, diverging in a more or less acute angle from the main axis, with their leaves distant, linear or lingulate, abruptly pointed; the first divisions, distichous, turned upward, are variable in length, some of them regularly pinnately subdivided in simple, short, obtuse branchlets, others elongated and simple from the middle. The leaves of the divisions are short and small, one to two millimeters long and about half as broad, closely imbricated and appressed upon each other, the upper outlines only being discernible, apparently placed in spiral order, a disposition, however, remarked upon a very small specimen (fig. 13), the only one where the thin coat of coaly matter is preserved, but not distinctly seen upon the large specimen (fig. 14), which is apparently a counterpart or impression, whereupon the leaves are marked only by black points, or short lines whose relative position is irregular. The species is related to *Widdringtonia antiqua*, Sap. (Ét., 2, 1, p. 69, pl. 1, fig. 4), by the form of the leaves, which, however, are more closely appressed in our species, and more distinctly in spiral order around the branchlets. The celebrated French author considers this American Conifer as very interesting and remarkable, representing either a new type or an *Arthrotaxis*, or even a *Dacridium*. Its generic relation is therefore indefinite.

HABITAT.—Point of Rocks, Wyoming Territory (*Dr. F. V. Hayden, Wm. Cleburn*); found in numerous but small specimens. The branch in fig. 14 is the largest; the others have only secondary divisions and branchlets, as in fig. 13.

TAXODIUM, Rich.

Taxodium distichum miocenicum, Heer.

Plate VI, Figs. 12–14 *a*.

Taxodium dubium, Heer, Lesqx., Annual Report, 1872, p. 389; 1873, p. 409.

Branchlets caducous, filiform; leaves distant or sometimes two close together, alternate, distichous, narrowed to the very short-petioled base, linear, obtuse, or obtusely pointed, flat, with a distinct middle nerve.

This species, described by Heer in the Arctic Flora as *T. dubium*, and separated in the Baltic Flora under the present name, is represented in our Tertiary flora by numerous fragments, branchlets only. The cones described and figured by the author as subglobose, with large scales marked in the middle by a transverse costa, umbonate at the center and verrucose, have not yet been found in our Tertiary measures. The leaves greatly vary in size,

sometimes being very small and narrow, as in fig. 12, sometimes comparatively broad, as in fig. 13, with a distinct middle nerve. Fig. 14 represents a branch with narrow leaves, and could be perhaps referred to *T. angustifolium*, Heer (Arct Fl., p. 156, pl. xxx, fig. 1). But the lower part of fig. 13 is evidently of the same character, and therefore seems to be a form of this variable species. The American specimens, like those described and figured in the Arctic Flora, have generally linear, slightly obtuse leaves, while those of the Baltic Flora have them slightly lanceolate. Fig. 14 *a* is an enlarged representation of fig. 14. The leaves vary in length from four to eleven millimeters, and in width from one-half to more than one and one-half millimeters.

HABITAT.—Elko Station, Utah (*Prof. E. D. Cope*), in numerous very fragmentary specimens. I found it also abundantly at Carbon, and it was collected in profusion at Fort Fetterman by *Lieut. Vogdes.* We have one specimen from Evanston.

GLYPTOSTROBUS, Endl.

Glyptostrobus Europæus, Heer.

Plate VII, Figs. 1, 2.

Glyptostrobus Europæus, Heer, Fl. Tert. Helv., i, p. 51, pl. ix, xx, fig. 1; Fl. Foss. Arct., p. 90, pl. iii, figs. 2–5, pl. xlv, figs. 20–22; Mioc. Balt. Fl., p. 20, pl. iii, figs. 8, 9, etc.—Lesqx., Annual Report, 1873, p. 409.

Glyptostrobus Ungeri, Heer, Fl. Tert. Helv., i, p. 52, pl. xviii.—Ludw., Palæont., viii, p. 71, pl. xii, fig. 6.

Glyptostrobites Œningensis, Al. Br. Stizen. Verz., p. 73.

Branches irregularly pinnately divided; branchlets variable in length, obtuse; leaves squamiform, imbricated, decurrent at base; male catkins ovate, single, sessile upon lateral branches; fertile catkins ovate, comparatively large; scales imbricated, semicircular, obtusely dentate on the borders, costate in the length; seeds ovate, with alate borders.

The fertile catkins of this species have not been found as yet in the American specimens communicated to me, but only fragments of branches and branchlets, like those figured here, some of them bearing male catkins, The description of the fertile cone is made from European authors. The shale bearing our specimens is, however, covered with remains of this species, branchlets especially, together with deep, oval impressions, which seem to represent crushed cones, whose scales are deformed and undeterminable.

HABITAT.—On thin soft shale, near Castello's Ranch (*Dr. F. V. Hayden*); near Florissant (*Prof. E. D. Cope*).

ABIETINEÆ.

SEQUOIA, Torr.

Sequoia affinis, Lesqx.

Plate VII, Figs. 3–5; Plate LXV, Figs. 1–4.

Sequoia affinis, Lesqx., Annual Report, 1874, p. 310.

Branches long, slender, pinnately irregularly divided; leaves short, oblong, or lingulate, obtusely pointed, imbricated, erect, or appressed; branchlets bearing fertile cones, open; strobiles small, oval, obtuse; scales large, rhomboidal, with entire borders, a central oval mamilla and wrinkles passing from it to the borders all around; branches bearing male catkins erect, with slightly more acute and longer leaves; catkins small, broadly oval, obtuse, covered to the top with imbricated, lingulate, pointed scales.

We have of this species numerous and well-preserved specimens, some of which are figured in pl. lxv, figs. 1–4. The divisions are generally pinnate, sometimes fastigiato-pinnate; the leaves linguiform, more or less abruptly narrowed to a point, decurrent, without apparent trace of a middle nerve. In the fragments represented in pl. vii, figs. 3–5, the leaves are more obtuse, as also the scales of the male catkins (fig. 5). These fragments may represent a different species, but they are too imperfect for exact specification. They may be even referable as variety to *Glyptostrobus Europæus*, being upon the same pieces of soft shale as those of figs. 1 and 2 of the same plate As represented in pl. lxv, *Sequoia affinis* has a remarkable affinity to *S. Coutsiæ*, Heer (Bovey-Tracey, Mioc. Fl., p. 1051, pl. lix, lx, lxi); still more to *S. Tournalii*, Brgt., as figured in Sap., Ét., ii, p. 2, pl. ii, fig. 1, and may be considered as an American form of this type. It merely differs from both species by the more obtuse point of the fertile, scale-like leaves, which are also longer and more gradually pointed upon the sterile branches; by the slender, longer branchlets, bearing the cones at their end only; by the more distinctly oval form of the slightly smaller strobiles, and by the absence of a middle nerve on the back of the convex or inflated leaves. The seeds, if the one figured in pl. lxv (figs. 4 and 4*a* enlarged) belongs to this species, are smaller, distinctly cordate, and obtusely pointed, bearing near the point a mere trace of a line, which divides, diverging on both sides toward the borders. In *S. Coutsiæ*, the seeds are oval-cordate, with a small, inflated, lanceolate-pointed nucleus, surrounded by a narrow wing. We have seen, however, only one of these seeds, and, though upon the same specimen as the branches of this species, its position does not positively indicate a relation to it. Moreover, those small bodies present varied forms, according to their position in the matrix wherein they are imbedded. One scale, enlarged, shows the wrinkles of the surface (fig. 1*a*); its borders are more inflated and

rugose than represented in those of the European species; fig. 3*a* is an enlarged fragment of a branch, with male catkins and leaves.

HABITAT.—Castello's Ranch (*Dr. F. V. Hayden*), specimens figured in pl. lxv; Elko Station (*Prof. E. D. Cope*), as represented in pl. vi, figs. 3–5. These last fragments were doubtfully referred to *Sequoia Langsdorffii*, Brgt., in Report, 1874, p. 410.

The two cones (figs. 5 and 5*a*), which, flattened by compression, merely show displaced apophyses somewhat similar to those of this species, are not positively determined. The scales are distant, seemingly scattered, more enlarged on both sides, bearing a central mamilla, from which numerous wrinkles, or striæ, are diverging around to the borders. They resemble the scales of *Geinitzia formosa*, Heer, of the Cretaceous flora of Quedlinburg; a distant likeness, however. The relation of these cones is still uncertain. They come from the same group, the upper division of No. 4.

Sequoia Langsdorffii, Brgt.

Leaves close together, rigid, coriaceous, linear, obtusely pointed, flat, open, distichous, narrowed and decurrent at base; middle nerve strong; cones broadly oval or subglobose; scales numerous, peltate, mucronate in the middle.

Though I have seen, upon specimens from different localities, especially from Black Butte, a number of detached leaves, apparently referable to this species, I have been unable as yet to find a fragment distinct enough for positive identification. It has been described by Dr. Newberry from numerous specimens obtained by Dr. Hayden from the Yellowstone Lignitic. Heer has it also described from very fine specimens, from the roof of the coal mines of Nanaimo, Vancouver's Island, as well as from Greenland and from Alaska. It is represented in Prof. J. D. Whitney's collection of Miocene plants of Oregon by specimens from John Day Valley, bearing branches and cones, in connection with *Betula macrophylla*, Göpp., *Quercus pseudo-alnus*, Ett., *Q. furcinervis*, Heer, *Platanus nobilis*, Newby., *Cinnamomum lanceolatum*, Ung., *Acer*, etc.; therefore its presence in the Colorado and Wyoming Lignitic may be admitted as more than probable. Even, as it has been suggested by critical remarks, the two forms described here below, under different specific names, may be mere varieties of it. In Europe, *Sequoia Langsdorffii* is one of the more generally distributed plants of the Miocene, and has been described, from numerous localities and under different names, by most of the paleo-phytologists: first *Taxites Langsdorffii*, Brgt., O. Webb.; it is *T. phlegetonteus*, *T. Rosthorni*, and *Cupressites taxiformis*, Ung., *Cupres-*

sites Hardtii, Goepp., *Chamæcyparites*, Endl., *Sequoia? Senogalliensis*, Mass., *Steinhauera minuta*, Sternb.; even *Taxodium dubium* and *T. laxum*, Ett. Its affinity to plants of the present flora is with *Sequoia sempervirens*, Endl., the Redwood of California.

HABITAT.—Black Buttes; Haley coal mines, with *S. longifolia;* Florissant (*Dr. F. V. Hayden*).

Sequoia angustifolia, Lesqx.

Plate VII, Figs. 6–10.

Sequoia angustifolia, Lesqx., Annual Report, 1872, p. 372; 1873, p. 409.

Branchlets short, slender; leaves at unequal distances, sometimes very close, two to three together or very distant, often dimorphous, linear-lanceolate, taper-pointed, open or curved backward, decurrent; middle nerve indistinct.

This form, though very variable, preserves its peculiar characters: the narrow, lanceolate, acute leaves, decurrent but not narrowed at base, with a thin, scarcely distinguishable, middle nerve. These leaves are not evidently distichous, but sometimes placed all around the branches. The cone is as yet unknown, but I refer to it the seed in fig. 10, which is oval, obtuse, and narrowly margined or winged. From the former species, to which it is evidently closely related, it differs by the consistence of the leaves, which are not as thick and not coriaceous; by their shape, narrower and more acutely pointed, not narrowed at the decurrent base; by the scarcely visible middle nerve. The similarity of this form to that described and figured by d'Ettingshausen in Bil. Fl., p. 34, pl. xii, figs. 1–13, as *Taxodium dubium* and *T. laxum*, is indeed striking, and as all these fragments have been identified with *Sequoia Langsdorffii*, our species should be, therefore, and has been, considered as a variety of this. But even here there is a marked difference in the form and position of the leaves, which are represented by the European author as all narrowed at the base and generally distichous, and another still in the seeds, which, though of the same form, are twice as large in the American species.

HABITAT.—Elko Station, Utah Territory (*Profs. S. W. Garman, E. D. Cope*).

Sequoia Heerii, Lesqx.

Plate VII, Figs. 11–13.

Sequoia Heerii, Lesqx., Annual Report, 1871, p. 290.

Branchlets slender; leaves short and narrow, distant, linear, obtuse or obtusely pointed, narrowed at the base and decurrent; middle nerve thin; strobile borne upon a naked pedicel, round, flattened at the top; scales peltate, rhomboidal, obtuse in the upper and lower side.

Except that the leaves are generally obtuse and narrowed to the point of attachment, and more distant, this species is similar to the former. The

leaves vary from three to seven millimeters long, averaging a little more than one millimeter in width, generally linear or slightly enlarged toward the point, of the same consistence as those of the former species, neither rigid nor coriaceous, with a thin middle nerve. As seen in fig. 11 *a* enlarged, they are evidently decurring upon slender branchlets, none as thick as any of those described and figured of *Sequoia Langsdorffii.* The cone, broadly globular and flattened at the top, is larger than that of this last species, figured in Fl. Arct., pl. ii, fig. 2, and about of the same form, and with few scales, but smaller than that of pl. xlv, fig. 14, of the same work. Therefore the difference in size is of no specific value, and also the total destruction of the scales or leaflets upon the pedicel may be considered as resulting from maceration. We have therefore merely, for specific character of this, the form, the size of the leaves, and their distant, irregular position upon the slender branches. *Sequoia Langsdorffii,* as figured in Flor. Alask. (pl. i, fig. 10), and *S. Nordenskiöldi*, Heer (Flor. Spitz., pl. iv, figs. 4, 34), have the leaves linear-obtuse, but they are rigid, coriaceous, close to each other, longer in the last species, twice as large in the former, with a thick middle nerve in both. Numerous specimens, all from the same locality, represent fragments or branchlets and cones with the same characters as those described here.

HABITAT.—Sage Creek, Montana (*Dr. F. V. Hayden*), in connection with undeterminable fragments of Ferns and some leaves of *Ilex dissimilis*, Lesqx.

Sequoia brevifolia, Heer.

Plate LXI, Figs. 25–27.

Sequoia brevifolia, Heer, Fl. Arct., p. 93, pl. ii, fig. 23; Mioc. Balt. Fl., p. 21, pl. iii, fig. 10; ix, fig. 5 c.—Lesqx., Annual Report, 1874, p. 298.

Branches somewhat thick, flexuous, pinnately divided; branchlets opposite, more rarely alternate, open toward the base, and diverging, curving upward and erect from the middle; leaves biform, either small, short, scaliform, lingulate, pointed, at the base of the branchlets or covering them when young, or longer, linear-oblong, enlarged in the middle, abruptly narrowed to a point, rarely obtuse, distichous, close to each other, oblique, gradually decreasing in length toward the top and the base of the branchlets; middle nerve distinct.

Besides the branch figured here, a large number of more fragmentary specimens, mostly branchlets, like fig. 26, have been sent from the same locality. This fine species is described by Heer (*loc. cit.*) from Greenland and from Spitzbergen specimens, and in the Baltic Miocene Flora from Krantepellen, North Germany. It is distinctly characterized by the form of its generally short, distichous leaves, abruptly pointed, sometimes slightly obtuse,

and generally enlarged above the middle and gradually narrowed toward the decurring base. We have, however, among the specimens a number of them bearing branches with narrower, nearly linear, closely approached, somewhat longer leaves, as seen in fig. 27, which show a notable deviation of the normal form, the leaves being on a more acute angle of divergence, parallel, and not turned backward. Between this and the normal form, the specimens show intermediate varieties, which recall them all to the more generally represented type, that of fig. 25. The leaves are seen enlarged in figs. 25 *a* and 27 *a*. The cone of this species is not yet known. One of the specimens from Point of Rocks, covered with scattered branchlets and leaves of this *Sequoia*, has a crushed cone (pl. lxi, fig. 30), which appears to be a flattened cross-section, or perhaps the flattened base of a strobile turned upward, the broken pedicel marking the central point around which the scales are imbricated from the center to the borders. The scales, as far as they can be discerned, are oblong, cuneate, narrow, emarginate, or irregularly crenate along the borders. They rather represent scales of a cone of *Glyptostrobus* than those of a *Sequoia*. The relation of this cone is therefore uncertain.

HABITAT.—Point of Rocks, Wyoming Territory (*Dr. F. V. Hayden*, *Wm. Cleburn*). Nearly one-half of the specimens of the collection of this last contributor represent this species in its various forms. The fine specimen in fig. 25 was kindly communicated by *Mr. E. H. Clarke*, agent of the Point of Rocks station.

Sequoia longifolia, Lesqx.

Plate VII, Figs. 14, 14 *a*; Plate LXI, Figs. 28, 29.

Sequoia longifolia, Lesqx., Annual Report, 1874, p. 298.

Branches and branchlets thick; leaves close, open, slightly recurved or erect, long, linear-lanceolate, acuminate, slightly narrowed to the decurring base, thick; scars deep, lingulate, obtusely pointed, marked by a deep groove in the middle.

As figured in pl. vii, fig. 14, the leaves are lanceolate, slightly narrowed to the base, less, however, than represented in the enlarged figure (14 *a*), gradually acuminate, with a broad, though indistinct middle nerve, and surface regularly thinly striate. The specimens in pl. lxi, figs. 28, 29, have the leaves much longer and narrower, linear, and also gradually narrowed to an acumen; their consistence is still thicker; they are more closely appressed and more numerous, forming by compression a coating of coaly

matter where they become mixed together and somewhat indistinct. The surface is less evidently and less regularly striate than in the other form, and they do not appear narrowed to their point of attachment. It may be, therefore, that these specimens, the first from Haley coal mine, the others from Point of Rocks, represent two different species. The leaves of figs. 28 and 29 are not distinctly seen to their base or to the point of attachment to the stems. The indistinctness of the specimens may account for the differences remarked above.

HABITAT.—Haley coal mine, ten miles northeast of Greeley, Colorado (*A. C. Peale*); Point of Rocks (*Dr. F. V. Hayden*).

Sequoia acuminata, sp. nov.

Plate VII, Figs. 15–16 *a*.

Branches thick, narrowly striate; leaves thick, rigid, with a thick, distinct, middle nerve, linear-lanceolate, gradually acuminate, narrowed to the decurrent base; surface smooth.

This species differs from the former by the proportionally narrower leaves, with a very distinct middle nerve, and smooth surface; also, by the stem, which is striate when decorticated, as in fig. 15, or naked and without scars, fig. 16. These differences may not be considered important enough to authorize specific distinction. The general appearance of the fragments representing both forms is, however, different; for the leaves of those ascribed to this species have a smooth and polished surface, appearing more rigid than those of the former, though their substance is not as thick. The average size of the leaves is about the same in both forms, the leaves varying from three to six centimeters long, and from two to four millimeters broad. These two species have a remarkable affinity to *Torreya Californica*, Tor., by the form, the consistence, and the disposition of their leaves. They, however, differ from *Torreya* by the evidently decurring base slightly narrowed, while in this genus they are rounded at the base to a short petiole.

HABITAT.—Black Butte, in the black shale of a lower coal than the main coal, opened at a short distance north of the station. No other vegetable remains were found in connection with these.

Sequoia biformis, Lesqx.

Plate LXII, Figs. 15–18 *a*.

Sequoia biformis, Lesqx., Annual Report, 1874, p. 298.

Stems or branches thick, irregularly pinnately divided; branchlets short, obliquely diverging; leaves of two kinds, either longer, linear, obtusely pointed, or shorter and broader, lanceolate, taper-pointed, and slightly, gradually narrowed to the decurrent base, generally incurved falcate, either distant and irregularly placed or crowded and imbricated; stems distinctly marked by triangular or lingulate-pointed scars.

This species bears two kinds of leaves, even upon the same fragments

of branches; either long, two centimeters, very narrow, linear, less than one millimeter broad, or shorter, broader, generally more crowded, lanceolate, taper-pointed, somewhat enlarged in the middle, and gradually slightly narrowed to the decurrent base, more than one millimeter broad and only eight to ten millimeters long; the middle nerve is clearly and deeply marked upon both kinds of leaves. In fig. 15, the leaves are short, much crowded, imbricate and falcate; fig 17 has very narrow leaves of various lengths, straight, or flexuous, or slightly falcate; figs. 17 and 18 have both kinds of leaves; some very short and narrow, some broader and longer. Besides the specimens with leaves variable in size, as pointed out in the figures, there is a large number of others where variations of form may be clearly seen, and, therefore, all evidently represent the same species. By the falcate form of the shorter leaves, it has some likeness to *Sequoia Reichenbachi*, Heer, of the Cretaceous.

HABITAT.—Point of Rocks (*Dr. F. V. Hayden*); found in numerous specimens. It appears, however, locally distributed, as the collection of Mr. Cleburn made at the same locality has not any specimens representing it.

ABIETITES, Goepp.

Abietites dubius, Lesqx.

Plate VII, Figs. 19–24.

Abietites dubius, Lesqx., Annual Report, 1869, p. 196; 1872, p. 374.

Branches thick; leaves open (those of the branchlets erect), loosely imbricated around the branches, lanceolate, gradually narrowing to a sharp point; broadest at the base, where they are abruptly rounded to the point of attachment.

This species, found first at the Raton Mountains by Dr. J. Le Conte and later by myself at the same locality in numerous specimens, has been also sent from different places, all the specimens presenting the same characters. The branch leaves, loosely imbricated, as seen in fig. 19, are generally more open, slightly narrower; those of the branchlets more erect and close; all exactly lanceolate, gradually narrowed to an acute point, abruptly rounded to the point of attachment, flat, concave inside, and marked by a thin, somewhat indistinct middle nerve; the stems bear distinct leaf-scars, presenting, as seen in figs. 19, 22, 23, 24, various forms, according to their age, their size, and the different stages of maceration and compression. The length of the leaves varies from seven to thirteen millimeters, the width from a little less to a little more than one millimeter; the substance is not coriaceous, and they appear easily destroyed by maceration, the branches and

branchlets found being very often divested of them, or with mere fragments, as seen in fig. 22. The cones of this species are as yet unknown.

HABITAT.—Raton Mountains, New Mexico, where its remains are very abundant (*Dr. J. Le Conte*). I found there mixed with them large pieces of bark, covered with large oval-obtuse tubercles, placed in rows; they seem referable to this species. Specimens in a good state of preservation were sent also from Fort Ellis by *T. Savage*, with mostly undeterminable fragments of dicotyledonous leaves. *Prof. B. F. Meek* obtained also, from chocolate clay shale underlying a bed of coal near Fort Steele, fragments of stems bearing scars similar in form and disposition to those of the branches of the Raton, These specimens, however, were without any leaves, the only other discernible remains, figured in pl. lx, fig. 37, being a fruit or scale of a cone, apparently referable to *Nordenskiöldia borealis?*, Heer.

Abietites setiger, Lesqx.

Plate VII, Figs. 17, 18.

Abietites setiger, Lesqx., Annual Report, 1872, p. 404.

Leaves distant, very narrow, needle-form, placed in right angle to and around the branches, or curving backward and reflexed from near the point of attachment.

None of the fragments representing this species are better than those which we have figured. The leaves, eighteen millimeters long, less than one millimeter broad, are exactly linear, filiform, grooved and nerved in the middle, abruptly pointed, and slightly enlarged at the point of attachment, distant, and, as seen from the scars upon the branches and placed all around them, either diverging in right angle or curved downward from near the base. Both this and the former species are without relation to any species of fossil Conifers known as yet from this country. But Count Saporta writes me that he is surprised to find that two forms apparently specifically identical with this and the former species are found in the Upper Cretaceous of France, that is, in the Lignite formations of Saint Paulet, Gard. He says:—"I have a specimen from Saint Paulet, which is like your figs. 17 and 18, and I have another, obtained from Brongniart, which is undoubtedly identical with your figs. 19 to 24." He adds that the horizon of the first species, *Abietites dubius*, ought to be the same as that of *A. setiger;* that *Sequoia biformis* is intermediate between them, and seems to unite both these so different forms, as possibly representing the same species. To this last supposition, I remark, that each of these three species, especially *Sequoia biformis* and *Abietites dubius*, is represented by a large

number of specimens, all with the same characters; that *Abietites dubius* cannot be referable to *Sequoia*, on account of the rounded and not decurrent base of the leaves, and that also *Abietites setiger*, with its punctiform scars of leaves, is, like the other species, forcibly separated from *Sequoia*.

HABITAT.—Six miles above Spring Cañon, near Fort Ellis (*Dr. A. C. Peale*). The specimens from Fort Ellis, obtained by Mr. Savage, have no fragments of this species, but have some of *Abietites dubius*. Per contra, those collected by Dr. Peale have none of *A. dubius*, but have also dicotyledonous leaves indifferently preserved, among which *Quercus Pealei*, Lesqx., *Rhamnus acuminata*, Web., and *Gymnogramma Haydenii*, are recognizable.

PINUS, L.

Pinus palæostrobus!, Ett

Plate VII, Figs. 25, 31.

Pinites palæostrobus, Ett., Foss. Fl. v. Hær., p. 35, pl. vi, figs. 22–33.—Ung., Icon., pl. xlii, figs. 16, 17.
Pinus palæostrobus, Heer, Fl. Tert. Helv., i, p. 56, pl. xxi, fig. 6.—Sap., Ét., ii, p. 70, pl. iii, fig. 1, iv, fig. 3 *a*.—Gaud., Cont., ii, p. 34, pl. i, fig. 8.—Heer, Mioc. Balt. Fl., p. 56, pl. xiii, figs. 1, 2.
Pinus polaris, Lesqx., Annual Report, 1873, p. 410.

Leaves by five, long, linear-filiform, abruptly pointed; middle nerve thick; lateral veins thin but distinct.

The first specimens obtained from this species were mere fragments of leaves, like those of the enlarged figs. 26 to 30, and were, by their narrow, filiform shape and their nervation, compared and referred to *Pinus polaris*, Heer, whose leaves are by two only, or of the *Pinaster* section of the Pines. The specimen in fig. 25 shows these leaves to be by five, and therefore of the section *Strobus*. The leaves are comparatively long, seven to eight centimeters, about one millimeter broad, flat or canaliculate, abruptly pointed, with a comparatively thick midrib, and two or three thin lateral veins on each side. The support is not clearly defined, the leaves appearing sessile upon a basilar receptacle, rather than surrounded by a sheath. Two of the leaves seem larger and shorter, as seen in fig. 25. They are apparently flattened fragments, do not show any trace of middle nerve and lateral veins, and may have been crushed after maceration; this would indicate for the leaves of this species a soft and at the same time a somewhat thick consistence. The fragment of branch (fig. 31), with its rhomboidal scars, seen enlarged in figs. 31 *a* and 31 *b*, appears referable to this species, though fragments like this may represent far different kinds of Conifers. One, for example, similar to this, is figured as *Glyptostrobus Europeus* in Heer (Balt. Fl., pl. xiv, fig. 13). A

longer and more slender branch, with scars of the same form, is, however, referred to *Pinus palæostrobus* by Saporta (Ét., 2, pl. iii, fig. 1 *d*). The species is described by d'Ettingshausen (*loc. cit.*) for leaves of the same form as ours, apparently flexible or soft, many being broken or curved. Saporta gives, besides the leaves and branches, a cone referable to it. As we have leaves only, the identification of our specimens to the European species is not positive. I have been unable also to see these leaves either square or triquetrous, as shown by a cross-section in Flor. Tert. Helvet., pl. xxi, fig. 6 *e*, and Flor. Balt., pl. xiii, fig. 1 *b*. They seem merely flat or canaliculate, and therefore keeled on the back. The specimens bearing fragments of this Pine have numerous seeds of Conifers, one of which, represented in fig. 33, does not bear any likeness to that referred to this species by d'Ettingshausen in Här. Fl., pl. vi, fig. 22, but rather resembles those of *Pinus polaris*, Heer (Spitzb. Fl., pl. v, figs. 9 and 10). The same shales have also large scales of cones in fragments, like that in fig. 32, with broad rhomboidal apophyses, rough and wrinkled lengthwise on the borders, and a large, deep, central cavity of the same form. Though these fragments may be compared to some species of Pines, they are undeterminable, and have been figured here as points of comparison for future researches.

HABITAT.—Near Castello's Ranch (*Dr. F. V. Hayden*); near Florissant (*Prof. E. D. Cope*).

TAXINEÆ.

SALISBURIA.

Salisburia polymorpha, Lesqx.

Plate LX, Figs. 40, 41.

Salisburia polymorpha, Lesqx., Am. Journ. Sci. and Arts, 2d ser., No. 81, May, 1859, p. 362; Annual Report, 1872, p. 404.

Leaves cuneiform, gradually enlarging from the base upward, irregularly more or less deeply cut in obtuse lobes; middle nerve distinct to half the length; veins very thin and close, slightly curving in ascending, many times dichotomous.

The leaves of this species, first described from Vancouver's specimens, are extremely variable. Cuneiform to the base, or enlarging upward, their borders are variously divided in more or less deep, generally obtuse lobes, sometimes split to the middle, sometimes merely wavy around the top, and marked downward by folds along the veinlets, which thus inflated are like multiple primary nerves, as seen in fig. 40, which is, however, made from an obscure specimen. In one of the Vancouver's specimens, the leaf of about

the same form as in fig. 41, but much larger, has six of these inflated veins, passing up from the base, parallel to the secondary veins, and the midrib is there indistinguishable. As far as they are known, the leaves vary in size from four to seven centimeters long, and from two to three centimeters wide across their upper divisions. The secondary veins are very thin, scarcely distinguishable without a glass, close, nearly straight up or slightly curved to the borders, forking in ascending. As remarked above, the specimen in fig. 40 is obscure, the veins indistinct, and the surface variously folded in the direction of the veins. Its reference to this species is not positively ascertainable.

HABITAT.—Six miles above Spring Cañon, near Fort Ellis (*Jos. Savage*).

MONOCOTYLEDONES.

GLUMACEÆ.

Gramineæ and *Cyperaceæ* are as yet poorly represented in the North American Tertiary flora; not so much on account of the deficiency of specimens as from the impossibility of determination of fragments of leaves or blades whose reference, even generic, is always problematic. I have, therefore, abandoned a number of species which I had formerly described as *Cyperites: Cyperites angustior?*, Al. Br (Annual Report, 1872, p. 403); *C. Braunianus?*, Heer (Annual Report, 1871, p. 285), which is characterized especially by its tubercles, while our specimens represent merely fragments of stems without them; *C. Deucalionis?*, Heer (Annual Report, 1871, p. 285; *Poacites lævis*, Heer (Annual Report, 1870, p. 385), etc., a fragment of which traverses fig. 1 of pl. xliii. As the determination of these species is still uncertain from far better specimens than those which we have in our possession, and as none better of the same kind have been discovered since 1870, it is advisable to leave them as undeterminable until others are found, which may afford some more light by the possibility of comparison. As seen in the description of species of *Arundo*, which are represented with positive characters, those of the seeds with glumes and pallets, and also of a *Carex*, we may expect from further researches important discoveries, and, therefore, the opportunity of more evident references for the fragments which are until now of uncertain affinity.

GRAMINEÆ.

ARUNDO, L.

Arundo Goepperti!, Münst.

Plate VIII, Figs. 3–5.

Arundo Goepperti, Heer, Fl. Tert. Helv., p. 62, pl. xxii, fig. 3, pl. xxiii.—Ludw., Palæont., viii, p. 80, pl. xvii, figs. 1–6.—Ett., Foss. Fl. v. Bil., p. 19, pl. iv, figs. 1–4.—Lesqx., Supplement to Annual Report, 1871, p. 5.

Culmites Goepperti, Münst., Beitr., v., p. 113, pl. iii, figs. 1–3.

Stems large, irregularly narrowly striate, marked with round knots; leaves large, flat, with thin veins, equal in distance, all of the same size.

The large fragment of stem (fig. 3) appears, by comparison with the description of this species by Heer, referable to this species. The lines covering it lengthwise, as also the round tubercles, irregularly distributed, are of the same character as in fig. 11, pl. xxii. The longitudinal larger striæ, mere irregular folds or splits of the epidermis, are not continuous. The specimen of ours, of which a part only is represented, is evidently of a very large stem, which, however, has been split and flattened; it does not bear any trace of articulation, and therefore may represent another kind of vegetable. The same may be said of the two fragments of branches or leaves in figs. 4 and 5, which have the same kind of nervation as the large leaves of *A. Goepperti*, but have no analogy whatever by their size. The surface, as seen in figs. 5 *a* and 5 *b*, much enlarged, is narrowly grooved or striate, but the veins are at equal distance, fig. 5 *b* representing them as seen enlarged twice, 5 *a* as seen enlarged eight times. The articulation and small tubercle in fig. 4 are characters of a branch, and not of a leaf; these fragments are found upon the same specimens with those of fig. 3, and from the same locality as those of the following species, to which they may be referable; they are somewhat inflated above the articulations.

Habitat.—On fine-grained, buff-colored shale, cut off along the railroad west of Green River, above fish-beds (*Dr. F. V. Hayden*). The specimens from this locality are now very rare; those of Dr. Hayden, which represent many fine and remarkable species, were obtained while the work of tearing out the rocks for the construction of the railroad was in progress. My own researches at the same locality, and long time after, did not afford any discovery of importance.

Arundo reperta, Lesqx.

Plate VIII, Figs. 6–8.

Arundo reperta, Lesqx., Annual Report, 1874, p. 311.

Stem thick, distantly articulate; surface striate, marked with round, obtuse knots, either placed at the articulation or here and there scattered upon the stem; fruiting panicle crushed, oval-oblong, bearing ovate-lanceolate seeds and pallets mixed with a coating of hairs.

The specimen figured as marked above is very interesting, and proves indeed, by the characters of the preserved organs, the reference of this plant to the genus *Arundo*. The thick stem, two and a half centimeters broad, somewhat flattened, very closely nerved or striate, with veins twice as close as they are in the former species, is distinctly and distantly articulate, with an indistinct knot under the convex narrow ring of the joint, and two larger convex tubercles at a distance above, in the middle of the stem. The same specimen bears a crushed ear, where glumes or pallets and seeds are mixed with a coating of short filaments, apparently hairs. The pallets in fig. 7 *a* are ovate-lanceolate, acuminate, rounded at the base, evidently veined in the lower part, slightly turned to one side at the point or straight. The seeds in fig. 7 *b* are shorter, but as broad at the truncate or subcordate base, ovate-lanceolate, pointed, striated on the borders around the convex central nucleus, measuring six millimeters from the base to the point and two and a half millimeters across below the middle. The same specimens bear numerous fragments of stems and rhizomas, or roots, like the one in fig. 8, which are all flattened, exactly linear, irregularly striate, and marked without order, or here and there with oval concave impressions, in the form of rings around central points, evidently scars of rootlets. As remarked above, these fragments may possibly represent the same species as the former. The stem, however, is more closely striate than the large one in fig. 3 of the same plate. It is comparable to that of *Phragmites Œningensis*, Al. Br., as figured by Heer (Spitzb. Fl., pl. vi, fig. 16). A pallet referable to the same species is also represented in fig. 15 of the same work; it is oval-lanceolate-obtuse, narrower than that of our species.

HABITAT.—Cut-off above Green River Station, Wyoming Territory (*Dr. F. V. Hayden*).

Arundo? obtusa, Lesqx.

Plate VIII, Figs. 9–9 *c*.

Arundo obtusa, Lesqx., Annual Report, 1874, p. 311.

Stem doubly veined, obscurely articulate, slender; primary nerves somewhat thick, with four or five intervening thinner secondary veins; pallets broadly ovate-lanceolate, acuminate or truncate; seeds large, obtuse, truncate at base.

The different organs preserved all together upon the same specimen in

fig. 9 may belong to a species of the same kind as the former. The characters, however, are somewhat different. The small stem, which, flattened, measures scarcely one and a half centimeters in width, is indistinctly articulate, and bears, just above the articulation, a round scar, about like that of the large stem in fig. 6, described above; but the nervation of the epidermis is double and distinct, the primary veins, two millimeters distant and comparatively thick, being separated by four or five secondary thin veins, as seen in the enlarged fig. 9 *c*, about as in *Phragmites Œningensis.* The other organs which I refer to the same species, and seen enlarged in figs. 9 *a* and 9 *b*, are two pallets and one seed. Of the first, one is broadly truncate at the base, rapidly narrowed to a truncate or bicuspidate point; the other is narrower, ovate-lanceolate, acuminate, rounded at base; both veined lengthwise. The seed (*b*) is truncate at the base, short, oblong, or lingulate, very obtuse, smooth, a little shorter than the pallets, but about of the same width, four to five millimeters long, a little more than three millimeters broad. The seed has not the form of those of *Arundo;* and, as these vegetable remains were found in connection with Palms, they probably represent some Gramen of a tropical or warm climate, like the *Bambusiæ.* I have, however, been unable to find any specimen with seeds for comparison. The stems and leaves of *Bambusia arundinacea* have the same nervation as that of our stem in fig. 9.

HABITAT.—Golden, Colorado; very rare, and found only in small fragments.

PHRAGMITES, Trin.

Phragmites Œningensis, Al. Br.

Plate VIII, Figs. 1, 2.

Phragmites Œningensis, Heer, Fl. Tert. Helv., i, p. 64, pl. xxii, fig. 5; xxiv, xxvii, fig. 2 *b*; xxix, fig. 3 *e*.—Ludw., Palæont., viii, p. 80, pl. xvi, fig. 1; xviii, fig. 2; xxiv, fig. 7.—Ett., Foss. Fl. v. Bil., p. 21, pl. iv, figs. 6–10.—Lesqx., Annual Report, 1870, p. 384; 1871, p. 289; Supplement to Annual Report, 1871, p. 10; 1872, pp. 374, 376, 391, 399.
Phragmites ? Œningensis, Al. Br., Stizenb. Verz., p. 75.
Phragmites Zannonii, Mass., Syn. Fl. Foss. Senogall., p. 8.
Culmites arundinaceus, Ung., Ett., Fl. v. Vien., p. 9, pl. 1, fig. 1.
Bambusium sepultum, Andræ, Fl. Siebenb., pl. ii, figs. 1, 3.

Rhizomas large, creeping, articulate; roots linear, with rootlets in right angle, placed in alternate rows or indistinctly along the divisions; stems long; leaves large, distinctly veined, like the stems, without middle nerve.

Fragments referable to this species, more common still in the European Tertiary than in ours, have been found in most of the localities where Tertiary fossil plants were discovered. The essential characters which serve to identify them are the creeping, articulate rhizomas, bearing at or from the

articulations flexuous branches nearly at right angle, two to three millimeters thick, linear, with two or three rows of radicles, more or less regularly placed, sometimes in lines, sometimes distributed without order, filiform; the stems articulated also, bearing scars of branches at the articulations, and striate in the length, like the leaves, with primary veins distinct, about two millimeters distant, and three to six thin veinlets between. As the plants of this kind were very large, easily crushed on account of their hollow stem, they are merely found in fragments; at least, we have never seen, in our Lignitic formations, large specimens of them; and these fragments, though referable to the typical forms, present a great diversity of shape. It is, therefore, probable that some of the references are uncertain, and that, when the species is known by better specimens and more distinct characters, some of the vegetable organs considered as pertaining to this species will have to be distributed with other kinds of vegetables. Thus the roots and rootlets first mentioned in Annual Report, 1870, p. 384, *as rather comparable* to those of *Phragmites Œningensis*, have been recognized and described (pl. vi, fig. 1) as those of a Fern, *Lygodium neuropteroides*. It must be remarked, however, that when these specimens were examined, they were the first ones seen from the Western Tertiary Measures, when we had no point of comparison whatever. This deficiency was already supplied, in a certain degree at least, for the Report of 1871, and here we have (p. 286) the species mentioned in numerous fragments of leaves, stems, and rhizomas from Elko Station. Then (p. 289) a fine stem, with articulations, scars, and branches, is identified with this species, from Medicine Bow's coal beds, whose station is referable to the Washakie group. In the supplement (Report, 1871, p. 10), a stem from Evanston is described, about half an inch broad, with primary veins deeply marked, strong, separated by thin intermediate veinlets, articulate, bearing at the articulation the round scar of a branch. It is more deeply striated than in most of the specimens figured of this species, agreeing, however, with a branch described by Sismondi (Paléont. du Piémont, p. 410, pl. vi, figs. 3–5). A stem of the same kind, and with the same character of nervation, is also mentioned in the same supplement (p. 13) as found with fragments of *Abietites dubius* at the Raton Mountains. In Report, 1872, p. 376, a fine specimen, with an articulation and scar, is described from the white sandstone under the Lignite beds of Golden. It is the specimen of our pl. viii, fig. 1. At the same locality, Prof. B. F. Meek discovered a number

of specimens with rootlets and their capillary filaments. From Marshall's coal mines, I obtained a number of fragments, especially of deeply striate stems without articulations, and of leaves with a less distinct nervation. From Black Butte, we have also roots and rootlets like those represented by Heer (Fl. Tert. Helv., pl. xxii, figs. 5*c*, 5*e*), and in the red baked shale of the same locality, specimens of the same kind. The species is especially abundant at the Cañon City coal beds, where a hard sandstone, at the base of the highest bluff, and already at a distance above the main coal bed, is filled by fragments of this species, and also in the hard white sandstone of Golden. The specimen represented by fig. 2 of pl. vii is from that locality, found by Mr. Wm. Cleburn. It is remarkably similar to the rootlets described by Ludwig, in Palæont., vol. viii, p. 80, pl. xviii, fig. 2*c*, as those of *Phragmites Œningensis*. In this sandstone, also, Mr. Cleburn found a cylindrical, somewhat conical, specimen, with articulations close to each other, the size of the stem or rhizoma diminishing with each articulation, and nerved like stems of this species.

As remarked by Heer, this *Phragmites* is closely allied to *P. communis*, which is very common through Europe and North Asia. The fossil species appears to have been larger, with broader leaves, without middle nerve. It is remarkable that, though recorded by most of the paleontologists who have had opportunity of studying vegetable remains of the Tertiary, its racemes and fructifications have never been seen, a single pallet only being described by Heer from the Miocene flora of Spitzbergen as referable to it. This celebrated author has described the species from a profusion of fragments of stems and leaves, in the clay shale of La Rochette, near Lausanne, some of them beautifully represented in pl. xxiv of his Fl. Tert. Helv.

HABITAT.—As remarked above, in most of the localities where Tertiary fossil plants have been found, except in the upper group 4 in Wyoming and Colorado Territories. It is especially abundant at Golden and Cañon City (*Dr. F. V. Hayden*, *Prof. B. F. Meek*, *Wm. Cleburn*, etc.).

Phragmites Alaskana, Heer.

Plate VIII, Figs. 10–12.

Phragmites Alaskana, Heer, Fl. Alask., p. 24, pl. 1, fig. 12.—Lesqx., Annual Report, 1871, p. 296.

Leaves narrow, nerved in the length; primary nerves distinct, less distant than in the former species; veinlets obsolete, discernible only under the epidermis, three in each interspace.

The fragments representing this species indicate leaves much narrower

than those of the former, and therefore a smaller plant. These leaves, from one to two centimeters wide, linear, obtuse or obtusely mucronate, are nerved in the length, with primary veins one millimeter distant, separated by three thin, obsolete, secondary ones. The substance of these leaves is hard and somewhat thick, the epidermis thin but corneous-like, covering the veins and veinlets, and rendering these indiscernible. This epidermis is, however, sometimes separable from the surface, and then the veinlets are distinctly visible. The specimen of our fig. 12 has the same size and appearance as that of Heer (*loc. cit.*, fig. 12). But in fig. 12 *b* of the Swiss author, the intermediate secondary veins are marked more numerous, or by six, though the primary ones are at the same distance, of one millimeter, as in our specimens. As the author remarks that the veinlets are obsolete, and as in the corticated specimens of ours the veinlets appear more numerous, on account of their indistinctness when seen through the epidermis, it is possible that the number of these secondary veins has not been distinctly seen, or that, as it is the case with *Phragmites Œningensis*, to which, according to the observations of Prof. Heer, this new species is closely allied, the veinlets are variable in number. Though I consider our species as identical with that of Alaska, I do not assert that it represents a *Phragmites*. If the leaf in fig. 10 is rightly placed, and is obtusely mucronate, this same character, though somewhat less marked, is seen in leaves of *Phragmites Œningensis*, as figured by Heer (Fl. Tert. Helv., pl. cxlvi, fig. 22); if, per contra, the specimen is overturned, and if that mucronate part represent the base narrowed to the point of attachment, this would force the separation of these leaves from the genus *Phragmites*, and indicate their reference perhaps to *Bambusia*. But it is possible that we have here two species, as that in fig. 12, which more positively agrees with Heer's description and figures of *P. Alaskana*, is from a specimen of a different locality from those of figs. 10 and 11, the only ones where the secondary nervation could be discerned by abrasion of the epidermis. These, therefore, might be referable to *Bambusia*, and that in fig. 12 identical with the species from Alaska. The relation of the specimens in figs. 10 and 11 is remarkably close to *Phragmites Cretaceus*, Lesqx., as described in Cret. Fl., p. 55, pl. xxix, fig. 7.

HABITAT.—Green River group, specimen of fig. 12, in connection with numerous leaves of *Ficus;* the others six miles above Spring Cañon (*Dr. F. V. Hayden*).

CYPERACEÆ.

CYPERUS, Linn.

Cyperus Chavanensis, Heer.

Plate IX, Figs. 1, 2.

Cyperus Chavanensis, Heer, Fl. Tert. Helv., i, p. 72, pl. xxii, fig. 7, xxviii, fig. 1, cxlvi, fig. 22.—Sism., Mater., p. 23, pl. vii, figs. 5, 6.—Ett., Foss. Fl. v. Bil., p. 26, pl. vi, fig. 3.—Lesqx., Annual Report, 1871, p. 300.

Leaves large, obscurely carinate in the middle, nerved; primary nerves variable in distance, intermediate veins three or more, crossed in right angle by transverse veinlets.

The fragment (fig. 1) represents apparently part of a large leaf of this species, like fig. 1 *c*, pl. xxviii, of Heer, *loc. cit.* It has, however, no trace of a middle nerve or of a carina, and the nerves are somewhat unequal in distance. It is the same in fig. 2, which has the primary nerves twice as distant, and seems to represent part of a stem of the same species. In both these specimens, the cross-veinlets are discernible by a strong glass. This species is apparently very variable. Sismondi (*loc. cit.*) represents a leaf narrower than our fig. 1, but indistinctly keeled, and the distance between the primary veins is the same as in our specimen; in d'Ettingshausen (Bil. Fl.), the same character of nervation is remarked; our specimen (fig. 2) has the primary nerves at a greater distance, double than that indicated in fig. 1; the spaces of different shades of color resemble the fragment figured by Heer (pl. xxii, fig. 7). These analogies are uncertain and obscure indeed, and I should perhaps have done better in leaving undescribed these fragments, as I have done for others formerly ascribed to this genus. They may be used for comparison with specimens of other localities. One from Evanston, for example, represents a flattened stem, one centimeter broad, without any articulation, obscurely striate, with primary veins distinct and variable in distance, and veinlets thin and joined by cross-branches. It has been also described as referable to the same *Cyperus*.

HABITAT.—Evanston, below the coal (*Dr. A. C. Peale*); Green River group (*Dr. F. V. Hayden*).

CAREX, Mich.

Carex Berthoudi, Lesqx.

Plate IX, Figs. 3, 4.

Carex Berthoudi, Lesqx., Annual Report, 1872, p. 377.

Leaves flat, marked by an obscure middle nerve and bordered by more distinct ones; intermediate veins thin, close, sometimes obsolete; seeds ovate or broadly oval, flattened, with oval more or less pointed and broader perigynia.

The leaves are all in small fragments, from the nature of the matrix

where the remains are preserved, a soft white clay cut in small cuboidal pieces by cleavage They are narrow, two to four millimeters broad, not canaliculate, but with a middle nerve sometimes indistinct, and narrow intermediate veinlets very close and thin, the ones nearest the borders somewhat thicker; the characters are seen in the enlarged figure 4 *a*. The seeds are numerous, more or less imbedded into the clay, and therefore of different aspect according to the plane of their position into the matrix; small, averaging two millimeters in length and only half as broad, ovate-rounded at one end, obtusely pointed at the other, with perigynia of the same form but slightly broader, forming rings around the achenia. Their different forms are figured enlarged double in *b* and four times larger in 3 *a*. Fig. *d* represents apparently a seed separated from its envelope, and fig. *c* a very small one, with the achenium attached to the base and not in the middle of the perigynium. All these different appearances result merely from the angle and degree of compression of these small organs. The fragments of leaves are related to those described by Heer in Spitzb. Fl., p. 48, pl. vi, fig. 45, as representing a fragment of the culm of *Cyperus arcticus;* but this has no trace of a middle nerve. The seeds are comparable to those of *Carex antiqua*, Heer (Balt. Fl., p. 28, pl. iii, figs. 18–20), but these do not have larger perigynia, forming borders as in ours.

Habitat.—Golden, South Mountain, in white soft clay, with remains of *Flabellaria Zinkeni* (*Capt. E. Berthoud*).

CORONARIÆ.

SMILACEÆ.

The species of this order of plants inhabit at the present time the tropical and temperate regions of both hemispheres. We have in the North American flora fourteen species; Europe has only three or four left in the Mediterranean regions. This small number is remarkable indeed compared with the great predominance of species of this order in the Tertiary flora of the same country, for no less than forty-four are described by European palæontologists from the Miocene of the south of France and Italy. A number of fragments of leaves of *Smilax* have been observed in the Lower Lignitic measures at Golden and Black Buttes; but they are mostly specifically indeterminable. The best specimens were obtained at Carbon. None have been

seen until now in the Green River group, and none in the Pliocene of California.

This seems a distribution in a contrary direction to that observed for Europe. It is, however, very probable that, as the leaves of *Smilax* have been found at two different stages of the Lignitic, and as even the type seems to be represented already in the Cretaceous of Nebraska by vegetable remains referable to the *Dioscoreæ*, the researches in the still unknown field of the North American flora will fill the gaps by new discoveries.

SMILAX, Tourn.

Smilax grandifolia, Ung.

Plate IX, Fig. 5.

Smilax grandifolia, Heer, Fl. Tert. Helv., p. 82, pl. xxx, fig. 8.—Ett., Fl. v. Bil., p. 28, pl. vi, figs. 15, 16.—Ung., Syll. Pl. Foss., p. 7, pl. ii, figs. 5–8.—Lesqx., Annual Reports, 1872, p. 385; 1873, p. 395.

Smilacites grandifolia, Ung., Chlor. Protog., p. 129, pl. xl, fig. 3.

Leaves broadly ovate, cordate at the base, gradually acuminate, seven-nerved, the two outside nerves ascending to the middle, the inside ones passing up in a curve to near the point; veinlets distant, oblique.

This leaf, about seven centimeters long (point broken), five and a half centimeters broad toward the base, where it is enlarged, cordate at base, curving and narrowing upward and apparently acuminate, is in all its characters of form and nervation identical with that in fig. 6 of Unger (*loc. cit.*). It merely differs by its smaller size, a character of no moment in leaves of this kind. The secondary veins are slightly more oblique to the middle nerve. This species is not rare in the Miocene of Europe; it has been described after Unger, by Heer, d'Ettingshausen, Weber, and represented by leaves of a shape and nervation more different from the typical form than ours, for the species varies much in the size and form of its leaves, some being as broad as ten centimeters, some merely rounded, not cordate, to the base. To this last variety may be referable a leaf described in Annual Report, 1873, p. 395, whose lower half only is preserved, round, not cordate, abnormally five-nerved by the division near the base of one of the lateral veins on one side, and on the other by a marginal veinlet from the top of the petiole; the nervilles are less oblique to the middle nerve than in the leaf which we have figured. The essential difference of this fragment, too incomplete for representation, is the round base of the leaf and its small size, of the same size as that of fig. 8 of Unger (*loc. cit.*).

HABITAT.—Carbon Station, in shale from below the main coal with *Equisetum Haydenii*, *Populus arctica*, and other Miocene species. The other leaf not figured has been communicated by *Dr. A. C. Peale*, from the white sandstone of Cañon City Lignitic Measures. I have found it also in fragments about three miles east of Colorado City, near the Gehrung coal, with *Sabal* leaves, and seen it also in fragments at Black Buttes. These fragments, too incomplete for determination, may belong to a different species.

SCITAMINEÆ.

ZINGIBERACEÆ.

ZINGIBERITES, Heer.

Zingiberites dubius, Lesqx.

Plate XVI, Fig. 1.

Zingiberites? undulatus, Lesqx.,* Annual Report, 1873, p. 396.

Fragments of a large leaf, outlines not preserved; surface equally undulate, multinerved, in right angle to the folds; primary veins distinct, parallel; intermediate veinlets six to seven, very thin.

The relation of these fragments is uncertain. They represent parts of a subcoriaceous leaf, with surface undulations formed by deep furrows, which, scarcely marked in some places, do not break the connection of the primary veins. These are somewhat thick, separated by six or seven thin veinlets, indistinctly seen through the epidermis. Of the three species of this genus published by Heer, the only one to which ours may be compared is *Z. multinervis* (Fl. Tert. Helv., iii, p. 172, pl. cxlviii, figs. 13–15). It represents some traces of the outlines of a large leaf, with a thick midrib, its surface distinctly nerved with somewhat undulate primary veins, which, as seen in fig. 15 *b*, have five thin intermediate veinlets. The character of the nervation is therefore the same as in the fragments which I refer to this genus, the primary veins being at the same distance, of about three millimeters, as in fig. 14, and in some places scarcely two millimeters, as in figs. 13 and 15 of the same author.

HABITAT.—Golden, Colorado Territory; very rare.

* The name of *Z. undulatus*, sp. nov., was employed by mistake in the short description of this species, the same having been used by Heer in Balt. Fl., p. 64, a work then unknown to me.

MUSACEÆ.

MUSOPHYLLUM, Goepp.

Musophyllum complicatum, Lesqx.

Plate XV, Figs. 1–6.

Musophyllum complicatum, Lesqx., Annual Report, 1873, p. 418.

Stipe thick, wrinkled-striate in the length; leaves large, with a thick, irregularly veined midrib; veins distinct, but very thin, simple or dichotomous toward the borders, more or less oblique to the midrib.

Stipe thick, wrinkled or striate, with parallel lines much larger and more distant and more irregular than the veins of the leaves; leaves very large with undulate entire borders, apparently parallel to the irregularly veined midrib, closely narrowly veined; veins thin, generally simple, scarcely one-third of a millimeter distant, sometimes forking near the borders, joining the midrib in an acute angle of divergence, then open and in right angle to it. The nervation is exposed in its details in fig. 3 *a*, representing the point of a small leaf, which seems attached by its whole base to the stipe.

The exact characters of these leaves, especially their form, their size, and their relation to the main stem, or stipe, are very obscure. I have found a bed of shale nearly one foot thick filled entirely with fragments of this species and detached leaves of a *Sapindus*, and have worked a whole day with a miner, trying, without avail, to get specimens more definite than those which are figured here. Large pieces of shale are covered with fragments of leaves, folded in various ways, where no trace of any middle nerve may be discovered. This proves the large size of these leaves, which, however, may be sometimes narrow and linear, as seen in fig. 1, where the borders are clearly defined on both sides of the large, flat, striate midrib, by a black, slightly inflated, undulate line, like that of the borders of fig. 2. The fragment in fig. 3 represents, it seems, a stipe with part of a descending rhizoma, which has the same kind of surface wrinkles, and above it a pedicel obliquely placed upon the stipe, and whose top is covered and obliterated by folded portions of leaves. The midrib, irregularly striate, is more distinctly seen in fig 1, and less so in fig. 2, where it is covered at the base by fragments, perhaps referable to leaves, but whose nervation is coarser and more distant than in any of the numerous portions of leaves of my specimens; the undulate entire borders are not laceration of a broad linear leaf, but true borders. Fig. 4 has the veins very close; it may represent the top of a young

leaf, the veins apparently converge toward the middle, as it happens sometimes at the top of a middle effacing nerve. The lower fragment of fig. 2 pertains to the same leaf split in the middle; it has its borders still more distinctly defined. The specimens bear these crushed leaves generally mixed with fragments of rhizomas and radicles (fig. 6), whose ultimate divisions are short, capillary, and so numerous that they cover sometimes whole specimens as by a thick felt, so that every kind of form and every trace of the stone are obliterated. The rootlets are linear, flattened, resembling those of *Phragmites Œningensis*, while the rhizomas, or perhaps their primary divisions, measuring seventeen millimeters in thickness, are straight, narrowly striate, like the diverging branches of fig. 3, exactly linear, with branches half as thick, passing down in an acute angle of divergence, bearing rows of somewhat distant scars, formed by double, deep, circular lines and a central vascular point. These roots and rootlets evidently pertain to this species, for the leaves of *Sapindus obtusifolius* are rarely mixed with those of this *Musophyllum*, and are found separately and in profusion at a little distance of the same bed of shale. Mr. Cleburn, who visited the same place, collected only leaves of *Sapindus*, with a single one of *Alnus Kefersteinii* and no fragments of *Musophyllum*. The surface of the leaves of our species is sometimes covered with parts of the epidermis, which, seen with a strong glass, appears marked crosswise with thin veinlets, as in *M. bilinicum*, Ett. (Bil. Fl., p. 28, pl. vi, fig. 11). But in this last species, the veins are not in an acute angle of divergence to the midrib, and then open and in right angle to it, a character remarked in the American form, and also in *M. bohemicum*, Ung. (Sillog., p. 8, pl. 1, fig. 13), which, however, differs by thinner, still closer veins, without cross-veinlets. Another species, *M. speciosum*, Sap. (Ét., i, p. 77, pl. v, fig. 2), is represented by a fragment without middle nerve, the veins being thin and crossed by veinlets, and therefore of the same character as in the American species, differing, however, by the position of the veins, very oblique to the borders. This last species is Upper Eocene, or from the Gypses of Aix; the others Miocene.

HABITAT.—Shale over a thin bed of coal, eight miles southeast of Green River station; referable to the Washakie group.

ENSATÆ.

This class of plants, and that of the *Fluviales*, so abundantly represented in the flora of the present time, have left very few traces of their life during

the geological epochs. Scarcely a dozen species have been described by European authors as referable to the first division; the second has about sixty, half of which belong to the genus *Potamogeton*.

HYDROCHARIDEÆ.

OTTELIA, Pers.

Ottelia Americana, Lesqx.

Plate LXI, Fig. 8.

Ottelia Americana, Lesqx., Annual Report, 1874, p. 300.

Spathe oval, narrowed to a round, striate pedicel, surrounded by an undulate, wrinkled fringe, truncate or emarginate at the top.

The figured specimen is the only one seen of this species. It represents an oval, tumescent, convex nucleus, the center of a spathe, wrinkled, striate in the length, three and a half centimeters long, seventeen millimeters broad in the middle, narrowed to a thinly striated or veined, half-round pedicel, twelve millimeters long and a little more than two millimeters broad. In the middle of the spathe, the longitudinal striæ are thick and deep, irregular, gradually passing toward the base to narrow, parallel lines, which enter the pedicel. This spathe is surrounded by an undulate wing, wrinkled across, eight millimeters broad in the middle, gradually narrowing to the base of the spathe, where it joins the enlarging pedicel. The cross-wrinkles of this wing correspond to the sinuses of the undulations.

The determination of this fine and remarkable species is due to Count Saporta, to whom I owe the communication of a good figure of *Ottelia alismoides* Pers., a living species of Ceylon. The only difference is that, in the living plant, a triphylle calix is persistent at the top of the spathe, while in ours its place is occupied by part of the wing, which possibly represents a flattened calix. No fragments of any other organs of this species have been discovered. Leaves of one species of this genus have been described by Saporta from the *Calcaire grossier* (Middle Eocene) of Paris.

HABITAT.—Point of Rocks (*Dr. F. V. Hayden*).

POTAMEÆ.

NAJADEÆ.

CAULINITES, Brgt., Ung.

Stems branching, striate, marked by sublunar and round scars; leaves flat, doubly striate; rhizomas plano-articulate, with double, irregularly round scars of branches, or warts and dots, marking points of attachment of radicular filaments.

This genus is slightly modified, according to the characters of the frag-

ments which I refer to it. The relations of the vegetable organs which have been described under this generic name are uncertain; the genus itself is thus temporarily limited.

Caulinites sparganioides, Lesqx.

Plate XIV, Figs. 4–11.

Caulinites sparganioides, Lesqx., Annual Report, 1872, p. 391.

Stems or rhizomas flattened by compression, cylindrical in the natural state, irregularly striate in the length, horizontally wrinkled, distantly articulate or marked across by semilunar scars, like impressions of half-embracing leaves, and irregularly round, large warts; branches alternate, distant; leaves flat, linear, veined.

It is indeed uncertain if all the fragments figured on the plate represent stems only, or if some of them are referable to rhizomas. The largest fragment of a stem of this species is three centimeters across. All the specimens which we have seen, and they are very numerous, are flattened by compression. They are, in the natural state, cylindrical, more or less inflated at the nodi, semi-articulate, or cut by a deep double line surrounding the base of the branches, embracing half the stems, as in figs. 4 and 10; they seem, however, to bear traces of real articulations, indicated by scars of rootlets surrounding them, as in figs. 5 and 6. If it is the case, these fragments might be considered as rhizomas and their branches, while the others (figs. 4, 7, 8, 10) would represent stems and branches, with sheathing-leaves under them. The presence of sheaths is marked under the branch-scars by the deep grooves, half embracing, in figs. 4 and 10; but one is seen also at the lower end of fig. 6, which, besides, has in the middle two distinct branches without appearance of sheath, and between them traces of an articulation. For this reason, the relative position of all the fragments is not clear. Fig. 8, for example, has in its lower part a branch similar to an unopened bud, with a round wart at its base, while the upper end shows like a bud of the same form, half sheathing or embracing, with apparently a fragment of a leaf behind it. The different representation of these two buds, or branches, may result from their position, the one at the top being seen flattened vertically, the other laterally. Fig. 7 shows the scar of a small branch, underlaid by a wart, a kind of scars considered and described by authors under this name, but which may be remains of abortive or adventitious rootlets. They seem to be very rare upon the parts which I consider as the branch-bearing leaves of the plants, as in figs. 4 and 10. These stems, when in a good state of preservation, are covered by

a comparatively thick pellicle of coal, which, cleaved in right angle, appears to have formed by compression the cross-lines visible upon the fragments in figs. 4 and 10. They are not remarked upon the others, which bear more or less distinct, irregular points, seemingly the scars of detached filaments or scales, as in fig. 9. I consider fig. 11 as a fragment of a leaf of this species. It is flat, exactly linear, twelve millimeters broad, doubly nerved; the primary veins are equidistant, one and a half millimeters, the space between being filled by eleven or twelve thin veinlets. The scars in fig. 10 present the peculiar appearance of a row of rays surrounding it, as seen sometimes around the branch-scars of *Equisetum.* From the appearance and difference of characters of the fragments figured, it may be supposed that they belong to different kinds of plants. I believe, however, that they are all of the same species; I found them, and studied them in place, all at the same locality, where, from a number of specimens which have not been figured, their different appearances and characters were seen evidently united by intermediate forms.

I was at first disposed to consider this species as identical with *Caulinites borealis*, Heer (Fl. Arct., i, p. 145, pl. xxiii, fig. 13), which the author supposes referable to his *C. dubius* (Fl. Tert. Helv., iii, p. 170, pl. cxlviii, figs. 1 and 2). But the characters do not agree, except perhaps in the round form of the warts, and even these have not inflated borders in our species. Heer figures and describes the stems as very narrowly and equally lined, while, in the American form, they are distantly and irregularly striate; the position of the warts is not the same, nor are the apparent articulations remarked upon the Miocene specimens from Iceland. In the same shale with these fragments, I have seen long, flexuous, ribbon-like rhizomas, fifteen millimeters broad, their surface wrinkled lengthwise, bearing long, linear, flexuous, simple rootlets, three millimeters broad, diverging in right angle. These rootlets come out single and opposite, or in whorls of two to four, from inflations at the point of attachment, and thus produce an appearance of articulation upon some of the primary roots or rhizomas. This agrees well enough with what is seen upon the specimens figured. The fragments in figs. 16 and 17 are of doubtful reference. The nearly regular position of the scars in rows, and the opposite branches, seem to separate them from this species. Saporta considers them as branches of *Salisburia.*

Habitat.—Abundant at Black Buttes in the sandstone above the main

coal; rare at Golden. I have also referred to this species, with doubt, however, a few fragments from six miles above Spring Cañon, in the collection of *Dr. Hayden*.

Caulinites fecundus, Lesqx.

Plate XIV, Figs. 1–3.

Caulinites fecundus, Lesqx., Annual Report, 1872, p. 384.

Branches of racemes two millimeters wide, smooth, inflated along the borders, divided in opposite, erect branchlets, half as thick, bearing on each side, and on short pedicels, simple round capsules inflated as by a central nucleus.

It is very questionable if these fine fruiting branches may be referred to this genus. They have this in common only: a monospermous (?) nucula with a cellulose envelope. As I have been unable to find either in the fossil species described until now, or in the collection of living plants which I was able to overlook, anything to which they had an apparent relation, I have left them in this as yet vaguely defined genus. The disposition of the nutlets along a narrow branch like a common rachis has some likeness to that of *Potamogeton*. The capsules are mostly opposite, close to each other along the branchlets, twelve or more on each side of an elongated common pedicel; one and a half millimeters broad, flattened, but with a convex center marked by a slightly smaller nucleus represented by a vesicle of coaly matter easily separated from its envelope (figs. 1*a* and 1*b*, enlarged). The fragment in fig. 2 represents the lower part of the raceme; it is narrowly, distinctly lineate in the length; but the divisions are smooth, with slightly inflated borders, as in the large middle branch of fig. 1. Fig. 3 represents a flattened linear fragment of a rootlet apparently detached from a rhizoma, as seen from the half-round scars which it bears near the upper end. These may be scars of smaller branches diverging around and from the axis, as in the former species. This fragment seems positively referable to the one described here, as no other kind of fluvial remains of plants were found in connection with it. It is lineate in the length, the lines regular and equal, crossed in right angle by narrow wrinkles, and thus has a facies similar to that of the stem (fig. 4) of the same plate. These racemes might represent the fruiting part of the former species (?). As remains of Palms were found in connection with them, they may be also the undeveloped flowers of some Palm. In the fourth volume of the Arctic Flora, Prof. Heer describes and figures, from the Jurassic of East Siberia, as a Fern, *Thyrsopis Maakiana* (p. 31, pl. i, figs. 1–3), which has, by its fruiting pedicels, a remarkable likeness to this species of the Lig-

nitic. But in this the nutlets are hard, compact, all of the same form, the young and the old ones, and thus unlike sporanges of Ferns. The analogy seems rather to be with the species described and figured as *Leptomeria gracilis*, Ett. (Foss. Fl. v. Här., pl. xiii, fig. 5).

HABITAT — Erie, Colorado, sandy shale above main coal.

FLUVIALES.

LEMNACEÆ.

Lemna scutata, Daws.

Plate LXI, Figs. 2, 5.

Lemna scutata, Daws., Rep. on the Geol. of the 9th Parallel, Appendix A, p. 329, pl. xvi, figs. 5, 6.—Lesqx., Annual Report, 1874, p. 300.

Frond round, entire, slightly undulate on the edges, single or grouped; roots numerous, filiform, proceeding from a round spot near the notch of the frond.

The fronds of this species, as represented in our figure, are eight to twenty-five millimeters broad, exactly round in outline, either and more generally naked, without radicles, or bearing a fascicle of filiform very slender rootlets from a narrowed base resembling a short pedicel. Those without radicles (as in fig. 2) show the basilar (?) part in the center of the frond, and thus resemble a flattened vesicular plant. In both figures, distinct veins are seen passing up from the short pedicel, or, as in fig. 2, diverging around from the center. Comparing them with those of the author's, the similarity of shape of the fronds is striking, but the fronds figured from Canada have scarcely any trace of veinlets, a few only being indistinctly marked in fig. 5 (*loc. cit.*), and the fascicles of radicles are attached, it seems, to the borders without any pedicel. From the observation of Prof. G. M. Dawson, who collected the specimens, this species is found upon shale breaking very easily, and no sufficient representation could be obtained of the species, though its remains were plentiful. As remarked by the author, it "*is associated with great quantities of roots and rootlets of filiform, subaquatic leaves*", and our specimens are in the same way intermixed to a mass of radicles, so thickly interwoven that it is not possible to precisely see their points of connection to the numerous fronds mixed with or deposited upon the tissue. Each frond, however, when considered separately upon detached fragments, looks as if it was completely surrounded by rootlets connected to or depend-

ing from it. From this it seems that the identity of these plants of Point of Rocks and of those described by Prof. Dawson is not positively ascertained. In my opinion, they represent the same kind of vegetables, and are referable to the following species, with which they are mixed.

HABITAT.—Point of Rocks (*Dr. F. V. Hayden*).

SPADICIFLORÆ.

ARACEÆ.

PISTIA, Linn.

Pistia corrugata, Lesqx.

Plate LXI, Figs. 1, 3, 4, 6, 7, 9–11.

Pistia corrugata, Lesqx., Annual Report, 1874, p. 299.

Leaves broadly obovate, incrassated from the middle toward the base, bordered upward by a wavy margin, gradually narrowed into a short pedicel with bundles of radicles at its base; veins going out from the pedicel in two or three compact fascicles, dividing in passing up from the base of the leaves, and forming, by cross-branchlets, large irregular polygonal meshes.

The leaves, round when young, are, when fully developed, broadly obovate or round at the upper border, gradually narrowed from the middle downward to a short pedicel, varying in size from two to six centimeters long and from two to four centimeters broad; nervation distinct, formed by the subdivision of veins, inflated into the pedicel, and dividing irregularly, in more or less dichotomous branches, in ascending to the borders, forming, by nervilles, oblique or in right angle, distinct quadrangular areolæ, which become smaller and quadrate along the borders. The lower part of the leaves appears inflated or thickened, and is generally surrounded by a deep line, the inside of which is slightly convex, and passes around and under a flattened border whose areolation is generally more distinct and smaller. This line is more or less discernible upon most of the specimens, which are very numerous; but sometimes it is marked near the base only, as in figs. 1, 4, 6, 7, and, when passing up, disappears into the meshes of the areolation along the inside line of the flat borders. Sometimes, as in fig. 3, it is more deeply marked upward, and disappears on the sides, leaving the lower part inflated as far down as the pedicel. In small, apparently young leaves, as in fig. 1, the circular line is less distinct, and its internal part does not seem inflated; even in very small leaves the borders are not separately traced, and the nervation is not disconnected from the base to the circumference.

This is remarked especially in the two specimens (figs. 2 and 5) which I have described as representing *Lemna scutata*, Daws., but which seem positively referable to this species; the first by its nervation from the center, appearing as if a leaf, like that of fig. 1, had been inflated and compressed, and its pedicel flattened to the central part, wherefrom the veins are diverging around, and in fig. 5, which, with the outlines of the larger leaves, has its primary veins ascending from the pedicel to the borders, scarcely divided as yet, on account of its incipient development. As the specimens are very numerous, distinct, and the leaves compressed and imbedded into the stone in various directions, it is not surprising to see this diversity of forms, which, however, is merely casual, and which seem explainable in comparing the fossil leaves to those of *Pistia spathulata*, Michx., of the swamps of Louisiana. These leaves have the same obovate shape, and the same type of nervation, by inflated primary veins diverging from the point of union of the pedicel with the lamina, and dividing upward in an irregular dichotomy, forming by cross-nervilles an areolation similar to that of the fossil species. Moreover, most of the leaves of the living plant, especially the old ones, bear on the under surface an inflated spongious coating, which covers them from the base to above the middle, especially along the primary veins, and which is exactly similar to that observable on the lower surface of the fossil leaves. It is true that the black lines encircling the intumescence are not remarked in leaves of *Pistia spathulata*. But they may be traced by folds caused by compression, the folding following of course the border of the part inflated by the peculiar deposit of the under side, which seems formed by an agglomeration of radicles and of their detritus by decomposition. In some of the fossil leaves, as in fig. 1, for example, the disconnection of the nervation along the lower rim of the flat border is scarcely noticeable, and, though more distinct in fig. 3, a slight folding along the rim would sufficiently account for it. It is not so easy to explain the central appearance of the pedicel or base of the leaf of fig. 2, just in the central part of an exactly round outline, if this specimen represents a leaf of the same kind. This could be done only by supposing that the lower part of the leaf with its pedicel has been folded up, compressed, and effaced by maceration, leaving only the space marked in the upper part of the leaf as trace of its existence. The lower part has not any veins, while the other half has them corresponding in size and mode of ramification

to those of the other leaves. As for the small specimen (fig. 5), it is scarcely possible to doubt its identity with this species; it is evidently a young leaf, the nervation is, as also its shape, of the same character. All these leaves are membranaceous except the middle inflated part, and in all, the veins are distinct, as if the substance of the leaves was transparent. The radicles, coming out in bundles from linear rootlets, confirm the reference of this species to *Pistia*, for *P. spathulata* has long flexuous rootlets of the same kind, with capillary radicles, often forming a coating on the surface of the water, and seemingly supporting the plants. Comparing these plants in any of their forms, none of them can be considered as representing species of *Lemna*, not only on account of their size, which, even in the smaller specimen (fig. 5), is greater than in any species of *Lemna* known at our time, but especially on account of the position of the radicles, which, in *Lemna*, are neither pediceled nor attached to the borders. This observation is applicable equally well to the plants considered as *Lemna* by Prof. Dawson.

No species of *Pistia* has been published to this time from fossil specimens. Count Saporta has recently found, in the Upper Cretaceous of Fuveau, France, leaves of this kind (*Pistia Mazelii*, Sap., ined.), a species which, as seen from the figures kindly communicated, has not any relation to ours.

HABITAT.—Point of Rocks, often covering large pieces of shale by numerous leaves and radicular filaments. Both *Dr. F. V. Hayden's* and *Mr. Wm. Cleburn's* collections have a large number of specimens representing this species only.

AROIDEÆ.

ACORUS, Linn.

Acorus brachystachys, Heer.

Plate XIV, Figs. 12–15.

Acorus brachystachys, Heer, Spitzb. Mioc. Flor., p. 51, pl. viii, figs. 7, 8.—Lesqx., Annual Report, 1871, p. 288; 1872, p. 385.

Scape round, narrow, striate lengthwise, distantly articulate; flowering ears oblique, small, oblong; flowers numerous, in spiral around the axis.

The scapes, four to seven millimeters thick and more or less distinctly lineate lengthwise, distantly articulate, bear small flowering racemes, either oblique or drooping, as in fig. 12, short, about one centimeter long and three to five millimeters thick. Our fragments, as represented especially in figs. 12 and 13, are so exactly similar to those described and figured by Heer (*loc. cit.*)

that it is impossible to doubt their identity with the European species; and though fig. 15 has the ears somewhat thick, this difference of size is marked also in both the specimens from Spitzbergen. Possibly figs. 16 and 17 of our plate are referable to the same species. They have been described in Annual Report, 1873, p. 410, as *Acorus affinis*, spec. nov.? Fig. 14 represents a young scape; fig. 15 *a* is the enlarged ear of fig. 15.

HABITAT.—Creston, Washakie group (*Dr. F. V. Hayden*, fig. 12); Carbon (figs. 13 and 14). Fig. 16 is from a specimen from Castello's Ranch, communicated by *Prof. Cope*, and as this locality is Upper Miocene, its identity with fig. 17, which is from Black Buttes and Lower Eocene, is therefore rendered doubtful.

Monocotyledones incertæ sedis.

ERIOCAULON, Gronov.

Eriocaulon? porosum, Lesqx.

Plate XVI, Figs. 2, 2 *a*.

Eriocaulon? porosum, Lesqx., Annual Report, 1873, p. 396.

Leaves basilar, rosulate, spreading, entire, linear-lanceolate, broader in the middle, gradually tapering upward to a slightly obtuse point and downward to the sessile (?) base (not seen); substance thick, spongious.

By the thick, apparently porous and spongious consistence, by the rosulate superposition, and by the form, these leaves are referable to this genus. They, however, differ by their larger size and the appearance of a middle nerve. As seen in fig. 2 *a*, enlarged, the middle nerve is traced by a broad, flat depression, along which the veins are parallel, as in some species of this genus; *Pæpalanthus melaleucus* and *Eriocaulum modestum* of Brazil, for example. The leaves of the fossil species, four to five centimeters long, seven millimeters across in the middle, are broader and longer, and have also the surface narrowly wrinkled across or in an oblique direction to the middle (fig. 2 *a*), these wrinkles tending downward and passing down along the borders, sometimes like anastomoses of the veins. The base of these leaves is either covered by superposition of others or destroyed; it is therefore impossible to further extend the comparison. *Abolboda poarchon*, Sieb., of Brazil, a species of the same group of the *Xirideæ*, also offers a likeness by its leaves to those of this fossil plant.

HABITAT.—Sand Creek (*Mr. W. H. Holmes*), with leaves of *Nelumbium* and other species found also at Golden, and therefore of Lower Eocene type.

Phyllites improbatus, Lesqx.

Plate XIV, Fig. 18.

Rhizocaulon gracile, Lesqx., Annual Report, 1873, p. 396.

Branches slender, irregularly forking; leaves (?) oblong, recurved or oblique, narrowed to a very short pedicel; nervation obsolete.

Comparing originally some fragments of this plant, all still more incomplete than the one figured, with *Rhizocaulon polystachium*, Sap., as figured in Schimper's Pal. Végét., pl. lxxx, fig. 8, I found a kind of likeness in the form of the spikelets, which, when crushed, as are some of the upper part of the figures, seem to represent a surface covered, like our plant, with a carbonaceous layer, marked in the middle by an indistinct depression like a midrib. I had not then obtained the admirable work of Saporta, *Études*, where the genus *Rhizocaulon* is not only described in detail, but where many fine species are illustrated. From it I had to see the double error of my former nomenclature and description, *Rhizocaulon gracile* being one of the species described by Saporta, and this fragment of ours being without relation whatever to species of this genus. It is still uncertain if the branch figured here bears leaves or spikelets rendered obsolete by compression. Some of the so-called leaves have no trace of a midrib, and seem mere flakes of carbonaceous matter of an oval, oblong, obtuse shape, seemingly narrowed to a very short pedicel, or sessile. The fragments should have been omitted, as of a character too uncertain for description, and are mentioned here merely to correct a double error of determination.

HABITAT.—Black Buttes, burned shale, above main coal.

PRINCIPES.

PALMÆ.

Specimens of Palm leaves and fruits are very abundant in the Lower Lignitic Measures of this continent, especially at Golden, the Raton Mountains, and in Mississippi. The number of species which they represent is large; but their characters, when taken from fragments of leaves, or from the rays only, are rarely definite enough to authorize specific or even generic separation. I have therefore described and figured only the types more positively characterized, either by their leaves or by their fruits.

The Eocene species of Palms, as represented by specimens of the Lower Lignitic formations, relate, as far as we know them until now, to three gen-

eral subdivisions of this family, and are accordingly distributed to the following genera:—

1. *Flabellaria*, Sternb., modified in the generic characters, and limited to Palm leaves or fronds whose rays are all attached to the top (either rounded, or truncate, or obtusely angular) of the rachis. This generic name has been employed, when referred to Palms only, for all the fossil species of this family whose relation is not well ascertained. But it seems an anomaly to describe in the same generic division species of Palms with flabellate leaves and acutely carinate rays, all attached to the top of an obtuse rachis, and others with either flabellate or pinnate fronds whose divisions are fixed along a generally narrow and very long rachis.

2. *Sabalites*. Fronds with rachis broad, often enlarged at the top, gradually narrowed up to a long acumen, bearing deeply carinato-costate rays attached along it, and flabellate, like *Sabal*.

3. *Geonomites*. Fronds with a long and comparatively narrow rachis, simple at first, but soon pinnately divided, or laciniate, with rays carinate or half-cylindrical toward the base, joining the rachis by their whole base, sometimes half-sheathing.

In describing *Flabellaria longirachis*, Ung., Schimper remarks, in Pal. Végét., ii, p. 492, that it evidently constitutes the type of a peculiar genus, which, by its characters, the length of the rachis, etc., seems intermediate between the Palms with flabellate and those with pinnate fronds. Count Saporta writes the same in regard to the species here referred to this genus, and believes, according to his remarks in Sézanne Flora, p. 339, that they constitute a distinct group, having some analogy with the *Geonoma* of the present time. This genus, according to Willdenow, who established it, is distributed by a number of species in tropical America, between 20° latitude north and 10° latitude south. Its characters have some analogy with those of the fossil species of this division by the fronds, at least, which at first, simple and flabellate, soon divide in irregular pinnæ, and become laciniate, the rays sometimes half-sheathing, etc.

With the fragments of Palm leaves, and in the same strata, numerous hard fruits have been found in the Lower Lignitic. They are especially common at Golden. As they bear the characters of fruits of Palm, it seems advisable to describe them separately under a more appropriate name than that of *Carpolithes*. The name of *Palmocarpon* is therefore used here for the clas-

sification of all the so-called *Carpolithes*, whose relation to Palms seems evident. The fruits attached to a Palm leaf, and apparently referable to the same species, are described under the same specific name as the frond.

The Palms, those "*noble children of the earth and of the sun*", as Martius names them, mostly inhabit the intertropical regions of the globe. They live in the humid bottoms of the equatorial rivers, of the Amazon especially, on the shores of the oceans, sometimes upon the slopes of high mountains, either in dense forests or solitary, or, perhaps, grouped a few together, in vast plains deprived of any other kind of arborescent vegetation. In the North American continent, they do not pass above the 34° of north latitude, following the same distribution upon the Atlantic and the Pacific slopes. In Europe, they reach the 43°; in the southern hemisphere, the 36°. The northern species, *Chamœrops*, or *Sabal*, are of small size, and, though elegant in their form, scarcely give an idea of the splendid, graceful shape, and of the enormous development, which impart to the vegetation of the tropics a character of magnificence and grandeur of which no description, no representation, may give a just idea. Trunks of Palms of less than one foot in diameter, cylindrical, simple, or clear of any branches, bear, one hundred feet and more above ground, their crowns of leaves, sometimes resembling fans, of such a size that one of them is large enough to cover and wall in the habitation of a whole family. The shape of these leaves, though most diversified, is always strikingly beautiful.

In the geological times, the Palms appear in the Cretaceous, wherefrom one or two species have been described in Europe. They become more predominant in the Tertiary, being already abundant in the Eocene period, where European paleontologists have discovered twenty-one species; and still more predominant in the Miocene, from which forty-two species are described, mostly from its lower divisions and from the South of Europe. No remains of Palms have been until now recognized in geological formations of Europe above 52° north. Heer has described none from the Baltic Miocene flora and none from the Arctic. In North America, there is an indistinct trace of the presence of Palms in the Cretaceous of Nebraska, by small fragments of striated leaves, described as *Flabellaria? minima*. In the Lower Lignitic Eocene, immediately at the top of the Cretaceous Measures, the Palms are already extremely abundant at Point of Rocks, at Black Buttes, and still more at Golden, where the Eocene facies of the flora is marked, as in Europe, by a profusion of remains of trunks, mostly silicified, and thus distinctly pre-

senting to the naked eye the well-known characters of the wood of the Palms. The collections of vegetable remains from the Raton Mountains are composed, for more than one-half, of fragments of Palm leaves. In the Eocene flora of the Mississippi, the proportion of Palms is quite as large, if not more, indicating, it seems, a small but gradual increase in the degree of temperature toward the south. We have, however, in the United States, specimens of large fronds of Palms from Fort Union, near the southern limits of British America, at about 50° of latitude north, and still higher, from Vancouver's Island, at 52°, the same latitude where, as seen above, the limits of Palms have been recognized in Europe at the Miocene epoch. From the Eocene times, the Palms seem to gradually lose in preponderance in the subsequent formation of this continent. No specimens of this kind of plants have been seen at Evanston, Carbon, or the Washakie (Laramie) groups. One species is represented in the Miocene of Oregon and one in the Pliocene of the chalk bluffs of Nevada County, California, a formation from which we know only fifty species of plants, whose characters indicate a climate analogous to that of the Gulf shores, or of the American Southern Atlantic States, at our time. Hence, a gradual diminution of atmospheric heat seems to have been continued from the Eocene to the Glacial epoch, at least, in considering the distribution of the Palms.

FLABELLARIA, Schp.

Flabellaria Zinkeni ?, Heer.

Plate IX, Figs. 6, 8.

Flabellaria Zinkenii, Heer, Boernst. Fl., p. 11, pl. ii, figs. 3, 4.—Lesqx., Annual Report, 1872, p. 377.

Rays linear, flat or obscurely carinate; primary veins distinct, with four to six intermediate thin veinlets.

I refer with some doubt to this species fragments of Palm rays found altogether in great number, but in such small specimens that the characters of the leaves are left indefinite. These rays, rarely conjoined, or generally separated like blades of grass, varying from five to seventeen millimeters in width, are flat, sometimes convex, as in *b*, fig. 7, or obscurely carinate, with thick primary nerves, slightly convex upon their surface, one to one and a half millimeters apart, separated by four to six thin intermediate veins, according to the distance of the nerves, and distinctly seen with the glass, as marked in the same fig. 7 *c*, enlarged four times. The best of our fragments have been figured here. Though very similar to those which have been figured

and described by the author, I cannot consider this species as positively identified with that of Boernstaedt, whose rays are lightly (*leviter*) carinate with intermediate veinlets sometimes three to eleven, though more generally five to seven, according to Heer's remark. Our specimens scarcely show any trace of carina, the primary nerves being sometimes convex, but they have all the same appearance upon larger or narrow rays; and the intermediate veinlets are four to six in number, rarely seven. In some fragments, as in fig. 8, the nerves are effaced, and the intervals, much larger, are apparently filled by numerous indistinct veinlets. The fragment *a* to *b*, fig. 7, apparently represents the same part as that of fig. 5 of Heer, *loc. cit.*, which the author considers as a floral involucre. The veins are all equal, and close to each other. The presence of these fragments among both the European and the American specimens, and their similarity of characters, seem to prove identity of species.

HABITAT.—Golden, South Table Mountain, in a stratum of white hardened clay, with *Carex Berthoudi.* Fragments apparently referable to this species are mixed with *Lygodium neuropteroides* from Barrell's Springs.

Flabellaria Eocenica, Lesqx.

Plate XIII, Figs. 1–3.

Flabellaria Eocenica, Lesqx., Annual Report, 1872, p. 391.
Sabal communis, Lesqx., Annual Report, 1874, p. 311.

Frond large, rays convex, semi-cylindrical toward the base, flattened in the upper part, diverging from the top of a broad rachis, distinctly nerved; primary nerves distant; intermediate veins thin, close, averaging ten in number; rachis truncate at its upper face, rapidly narrowed to a point on its lower

The two figures (1 and 2) are counterparts, and therefore show the two sides of the fragment of a frond and of its petiole. The rachis is flat or about four to five millimeters thick in the middle, cut in a broad angle on the upper side, more elongated on the lower, the prolongation measuring about two and a half centimeters, with the tip abruptly and obtusely pointed; surface very narrowly and somewhat irregularly veined lengthwise. Rays all attached to the top of the rachis, round truncate at base, comparatively few, about thirty, diverging on both sides at right angle, deeply carinate, without costæ at the upper, half-round surface, rapidly increasing in width, and flat in the upper part of the frond; carinæ broadly costate; primary veins more or less distant and thick, generally black when the epidermis is removed, one to two millimeters apart; intermediate veins thin and numerous, ten to twelve in the intervals of two millimeters. I refer to this species the frag-

ment of fig. 3, which shows the same kind of nervation, but more distinct than in figs. 1 and 2. In fig. 1, however, the impression of the right side of the specimen shows the rays flat, or nearly so, like those of fig. 3, with distinct though very thin veinlets. Fragments of this kind are very common at Golden, at the same locality where I could compare them in place; but I was unable to find any larger part of the fronds, which, considering the petiole, do not seem to have been of great size. The species is comparable to *F. Lamanonis*, Brgt., as described in Sap., Ét., i, p. 70, pl. iv, fig. 5, and especially to *F.* (*Sabal*) *Andegaviensis*, Schp., Pal. Végét., ii, p. 490, a species not yet figured, but which, according to the observation of Saporta, is closely related to that of Golden, and is found in the Upper Eocene of La Sarthe, France. *F. Lamanonis* is from the same formation, the upper part of the Gypses of Aix. The position of the rays at the top of the rachis, not passing lower and not narrowed to an acute base, seems to indicate the reference of this species to *Flabellaria* rather than to *Sabal.*

HABITAT.—Golden, especially common at the locality called *Table Mountain*, south of the School of Mines; Black Buttes, where I found the specimen of figs. 1 and 2

SABALITES.

Sabalites Grayanus, Lesqx.

Table XII, Figs. 1, 2.

Sabal Grayana, Lesqx., Trans. Am. Philos. Soc., xiii, p. 412, pl. xiv, figs. 4–6.

Frond large; rachis dilated under the rays, taper-pointed and acuminate; rays very numerous; primary veins thick, nearly at equal distance; intermediate veins distinct, few, one to four.

This species is represented by fronds of large size, of which, however, we have not seen any fragments better preserved than that figured here. The rachis is broad, flattened and split at the top by compression, as seen on the right side of a casually superposed fragment of a ray, gradually narrowed, acuminate, fourteen centimeters long from the dilated part under the rays, and here six centimeters broad, regularly striate, as seen only near the borders, under the lowest rays, where the epidermis is not destroyed, merely convex downward, at the part where it is broken. The very numerous rays, ninety to one hundred, attached all along the point of the rachis, are deeply carinato-costate, slowly enlarging upward, distinctly nerved, at least where the epidermis is preserved; nerves thick with few intermediate distinct veinlets. In the specimens figured here, where we have only the

base of the rays, these intermediate veinlets are only one to three (figs. 1 *a* and 1 *b*), but of course the nerves are more distant and the intermediate veins more numerous in the upper and enlarged part of the rays, where they are generally four to six. In some fragments of large rays from the Mississippi flora, I have counted as many as ten of these veinlets. The relation of this species to that of Mississippi is especially marked by the form of the rachis, enlarged under the rays, and gradually narrowed to a long acumen. This gradual narrowing of the rachis and its enlargement are distinctly seen in fig. 4 of the Mississippi flora, as also the large number of rays and the nervation in separate fragments, figs. 3 and 4, showing also the very slow increase of the width of the rays, and therefore the large size of the frond.

Fig. 2 of our plate represents a part of a large petiole found at Golden with other remains of Palms, and perhaps referable to this species. The specimen is twenty-two centimeters long; its form is triangular, obtusely carinate; the size eight centimeters thick at or near its base, and only half this at the part where it is broken. The rachis under the rays of fig. 1 seems to indicate a still thicker petiole; but it is here flattened and therefore enlarged; moreover, the stalks of species of *Sabal* are rather narrower at a distance from the fronds than under the rays. The character of coarse regular striæ is the same on the border of this petiole as remarked under the rays of fig. 1.

HABITAT.—Golden, Colorado, hard sandstone, between coal banks; Point of Rocks, Wyoming (*Dr. F. V. Hayden*). It was first described from Vancouver specimens.

Sabalites Campbellii, Newby.

Sabal Campbellii, Newby., Notes on Extinct Floras, p. 41, pl. x, (ined.).

Leaf very large, eight to ten feet in diameter, with fifty to eighty folds; petiole long, one and a half to two inches wide, flat above, without a central keel above or below, unarmed; nerves numerous and fine, about fifty in each fold; six principal ones on each side of the midrib, with three intermediate ones between each pair, the middle one being strongest.

As this species has been carefully described and finely figured by its author, and as his plates may soon be published, I have abstained from representing it in this memoir. Moreover, the very numerous specimens which I refer to this species, from a comparison with a fine one from Yellowstone, labeled by Dr. Newberry, and furnished me by Dr. F. V. Hayden, merely represent fragments of rays or rachis, and are not all perfectly concording to the above description. The more striking characters of this species are: the sharp folds of the rays, with keel deeply, narrowly grooved, and their upper

part also sharply and acutely nerved; the nervation obscured by a rough epidermis, in such a way that the primary veins are scarcely discernible even with the glass, and the intermediate ones totally obsolete. From the former species, it greatly differs by the abruptly narrowed, shorter, though acuminate point of the rachis, which is convex on the under surface, rough in the middle, smooth only on the borders, where it is marked by parallel obtuse striæ, three millimeters distant; by the less numerous rays more distinctly and sharply carinate; and by the obsolete nervation. It is from this character especially that I referred to this species, in Supplement to Annual Report, 1871, a large number of specimens from Fischer Peak, of the Raton Mountains, where they were collected by Dr. Hayden's expeditions, and later by myself. It is there very abundant, for, except one, all these specimens of Palms of Dr. Hayden, forty-seven in number, represent it in fragments of leaves, of petioles, of stalks, of racemes, and fruits. My own specimens are of the same kind. As mentioned in Annual Report, 1872, p. 375, I found it at the Gehrung's coal, near Colorado City, then abundantly at Golden, with fruits of Palms (Annual Report, 1872, pp. 383, 391), and at Black Buttes, in the Saurian bed, where I obtained even fragments of leaves glued to fragments of bones of *Agathaumas sylvestris* (Annual Report, 1872, p. 398). In all these specimens, the character of the nervation is the same: numerous primary veins, ten to twenty in each half-ray, indistinctly perceivable under the rough epidermis, and no trace of intermediate veinlets. As seen in the description of the fruits which I refer to this species, they have been obtained in most of the localities where fragments of leaves were found. I have also, referable to it, the base of a petiole ten centimeters broad, merely convex, and rays four and a half centimeters wide, the largest which I have seen of this species.

HABITAT.—Fischer Peak, Raton Mountains, New Mexico (*Dr. F. V. Hayden*); Gehrung's coal, Colorado, Golden, Black Butte, etc. *Dr. Newberry* has it from the Fort Union Lignitic, Bellingham Bay, etc.

Sabalites fructifer, sp. nov.

Plate XI, Figs. 3, 3 *a*.

Flabellaria? fructifera, Lesqx., Annual Report, 1873, p. 396.

Frond palmate; rays numerous, from a long acuminate rachis, acutely carinate, nerved; fruits oval-obtuse, narrowed to a short pedicel, borne in a loose raceme.

The fragment of the lower part of a palmate frond seems to be refera-

ble to *Sabal* by the acuminate rachis, which bears on both sides numerous rays enlarging and diverging upward. The rachis is not very distinct, but as far as it can be seen it looks narrowed into a point, or with an acumen, along which very numerous rays are attached; they descend lower than the acumen in diverging, as if it had been long and linear. The generic relation of this Palm is therefore uncertain. The very numerous rays, enlarging upward from a narrow base, crowded, pressed upon each others, and folded in their direction, as if the leaf was young and undeveloped, are sharply keeled and distinctly nerved, though narrow; the primary nerves one millimeter apart, have apparently two or three intermediate veinlets, which are slightly discernible. The fruits are probably referable to the same species, as they are not only seen at the base of the leaf, but more numerous still imbedded into the stone. Their form is like that of small obtuse spindles, attached by short pedicels to a loose raceme. These fruits are fifteen millimeters long, five millimeters thick, surrounded by a thin, shelly pericarp, which, more or less distinctly and thinly ribbed lengthwise, is crossed by short wrinkles or splits. They are comparable in form and size to those of some living species of *Astrocarium*, like *A. Sauri*, Mart., to which, however, the leaf has no relation.

HABITAT.—Golden, South Mountain.

GEONOMITES, Lesqx.

Frond large, palmato-pinnate; rays connected in the lower part, separating outside, joining the rachis by their whole, sometimes half-sheathing base, obscurely carinate.

Geonomites Goldianus, Lesqx.

Plate IV, Fig. 9.

***Palmacites Goldianus*, Lesqx., Annual Report, 1874, p. 311.**

Leaves flabellate; rays flat and without carinæ, joined in an acute angle of divergence, and, by their whole base, to a narrow, linear, flat rachis, with narrow furrows marking line of separation; primary veins generally distinct, with ten intermediate veinlets, sometimes discernible with naked eyes.

The leaf, represented by one fragmentary specimen only, is subcoriaceous, the surface being covered by a thick, pellucid, and shining epidermis, which, destroyed in some places, leaves the nervation quite distinct. The primary veins, however, are visible through the epidermis. The rays average one and a half centimeters broad, are united, their borders being indicated by a narrow furrow; flat, joining the rachis by their whole base, neither narrowed nor decurrent to it; their angle of divergence being about 20°. The primary nerves, two and a half millimeters distant, have generally ten inter-

mediate veinlets, which, though very close, are clearly seen where the epidermis is destroyed. The flat, narrow rachis, apparently linear, is five millimeters wide, nerved, the middle veins being stronger than the two secondary ones on each side of it. This part of frond is closely allied by its characters to *Flabellaria Zinkenii?*, Heer, described above from specimens found at the same locality. As no account can be taken of the rachis, which was not observable in *F. Zinkenii*, we have only the rays for point of comparison. In the present species, the rays are quite flat, broader, all connected; the primary veins are distinct, but neither prominent above the surface, nor as thick; and, discernible through the epidermis, they are more distant, and have generally ten intermediate veinlets, visible only where the epidermis is removed. This fragment therefore represents a distinct and peculiar species. Its relation is to *Ludoviopsis geonomæfolia*, Sap. (Séz. Fl., p. 339, pl. iv, figs. 1, 3). In considering fig. 1 of this flora as a young leaf, whose narrow linear rachis is indicated from above the petiole, and fig. 3, regarded by the author as pertaining to another species, *L. discerpta*, as a fragment of an old leaf of the same, both united together would show us some of the characters which have been described above, viz, beside the rachis, the narrow flat rays, which in their conjunction join the rachis by their whole base in a very acute angle of divergence. The primary nervation of the fragment (fig. 3) is, it seems, the same as in the American species; it is, however, too obscurely indicated for a reliable comparison.

HABITAT.—Golden, Colorado; South Mountain.

Geonomites Schimperi, sp. nov.

Plate X, Fig. 1.

Frond large; rays flat, obtusely carinate, half-sheathing or decurrent to a narrow rachis, obscurely nerved; primary veins thick or inflated; intermediate nerves few, three or four.

The specimen represents a portion of a splendid, evidently long and large leaf. The rachis is narrow, not more than four millimeters thick at the lowest part of the specimen, very slowly decreasing in size, as, at the top of the specimen, which is twenty-two centimeters long, it still measures three millimeters. It appears half-round and striate, but is only distinct at a few places, the rays apparently covering it by their decurrent or half-sheathing base. The rays are scarcely narrowed at the base, enlarging a little above it, and connected by their borders, thence decreasing upward, soon disjointed, and thus palmato-pinnate; they average in width two and a half centimeters

a little above the rachis. Marked in the middle by a deep midrib, and thus subcarinate, they show on both sides of it ten to fourteen inflated primary veins, with few intermediate veinlets, two to four discernible only, and even rarely, after abrasion of the epidermis. The substance of the fronds is thin, membranaceous, of a dull red color, a character which may be casual.

I do not know of any fossil species of Palms to which this one may be compared. *Flabellaria longirachis*, Ung. (Iconog., p. 19, pl. viii, ix, fig. 1), has a very long and narrow rachis, but its smooth surface, as well as the characters of the palmate rays, are far different.

Habitat.—Divide between sources of Snake River and the southern shores of Yellowstone Lake, with *Gymnogramma Haydenii* (*Dr. F. V. Hayden*).

Geonomites tenuirachis, sp. nov.

Plate XI, Fig. 1.

Flabellaria longirachis?, Ung., Lesqx., Annual Report, 1873, p. 396.

Frond elongated, apparently linear in outline; rachis very narrow, grooved in the middle; rays joining the rachis by a decurrent base, obtusely carinate; nervation obsolete.

The only specimen seen of this species is figured. It appears to represent the upper part of a long, linear-lanceolate frond, palmato-pinnate, with a very narrow rachis, to which the rays are attached in an acute angle of divergence, scarcely 20°. The rachis is about two millimeters thick, smooth, and grooved in the middle. The rays, obtusely carinate, narrow, about one centimeter wide, including both faces, become flat and slightly decurrent toward the rachis, curve inward in narrowing, and seem to become free or cut from each other toward their points. The substance is thick and coarse, the nervation nearly totally obsolete, except where the rays, destroyed by maceration, have left indistinct traces of nerves, as marked upon the right side of the figure.

I referred, with doubt, this form to *Flabellaria longirachis*, Ung. (*loc. cit.*), from the size of the rays, their obtusely carinate and rough surface, together with the obsolete nervation. But in Unger's two figures, which, fine as they are, show more than is remarked in the description, the rachis is of a different character, the rays being half-cylindrical, very long and linear, connected in their whole length. Our too small specimens may, however, be the point of a long frond, whose base would be represented by both Unger's specimens. In this case, however, as in others, where identity with European

species is doubtful, it is advisable to use different names in consideration of suggestive modifications of characters by influence of geographical distribution.

HABITAT.—Raton Mountains, near Fischer's Peak (*Dr. F. V. Hayden*).

Geonomites Ungeri, sp. nov.

Plate XI, Fig. 2.

Frond large, flabellate or flabellato-pinnate (?); rays numerous, undivided, half-round, narrow, joining by their whole base a broad, nerved rachis.

The fragment is comparatively small, but some of the characters of the leaf which it represents are clearly defined. The frond was a very large one, as seen from its broad rachis, which, though broken in its length, is still two centimeters at its base, apparently gradually decreasing upward, and distinctly striate, at least toward the base, where it is somewhat concave. The leaf accordingly seems to have been broadly linear-lanceolate. The numerous narrow, inflated rays join the rachis by their whole base, neither narrowing nor decurring to it, passing up in an acute angle of divergence, 25° to 30°, and slightly curving inward. They are nearly linear, five millimeters at the base, flat underneath, as seen in the upper part of the specimen, which is merely a counterpart of the under side of the rays, and here marked by nerves about two millimeters distant, with four or five thin intermediate veinlets. The veinlets upon the petiole are of the same kind, but without primary nerves.

As far as can be seen, this species is distantly related to *Manicaria formosa*, Heer (Fl. Tert. Helvet., i, p. 92, pl. xviii), where is figured a splendid specimen, whose rachis is, however, totally destroyed. From the distance of the rays at the base, this rachis seems to have been broad. The relation is especially in the size, the inside curve, and the nervation of the rays, which, however, in our specimen, join the rachis at a more acute angle of divergence than in Heer's species, are half-round above, the line of separation being marked by a deep groove. In considering the generic relation of his species, Prof. Heer remarks that it is not referable to *Geonoma*, whose fronds have a narrow rachis, with rays in an acute angle of divergence. This American species therefore would be related to *Manicaria* by its broad rachis only, but differ from it by the more acute angle of direction of its half-cylindrical rays, which relates it to *Geonoma*.

HABITAT.—Raton Mountains, New Mexico (*Dr. F. V. Hayden*). The same specimen bears the leaf described as *Ficus Smithsoniana*.

PALMOCARPON, Lesqx.

Fruits of various size and forms, generally surrounded by a shelly pericarp, and found in connection with remains of Palms.

Palmocarpon compositum, Lesqx.

Plate XI, Fig. 4.

Carpolithes compositus, Lesqx., Supplement to Annual Report, 1871, p. 16.

Fruits oval, obtusely pointed, narrowed to the base, where they are joined five together, striate in the length.

The specimen represents a fragment of a short pedicel, to which five oval nutlets are attached close together, the upper ones larger and apparently crushed, the middle ones oval, obtusely pointed, one and a half centimeters long, seven millimeters thick in the middle, the lower one smaller, all distinctly striate in the length. This species seems related to the fruits of *Sabal ? fructifera* (fig 3 of the same plate). The upper part of the specimen is, however, crushed. Their union to a short pedicel of a close raceme relates them to the fruits of some Palms, as seen when enveloped in their spathe.

HABITAT.—Placière Mountain, New Mexico (*Dr. F. V. Hayden*).

Palmocarpon Mexicanum, Lesqx.

Plate XI, Fig. 5.

Carpolithes Mexicanus, Lesqx., Supplement to Annual Report, 1871, p. 17.

Fruit rounded on one side, rapidly narrowed to a point, surrounded by a shelly envelope, smooth or without distinct striæ except a few near the point.

This fruit is broadly ovate, pointed or round on one side, narrowed to a truncate point, twenty-five millimeters long and sixteen millimeters across the middle; its surface is smooth, without striæ, but with a few irregular splits, which show a thin shelly pericarp.

This fruit is comparable to those of many species of Palms, especially those of *Astrocaryum* and *Bactris*, like *Bactris macrocarpa*, Wall., *Astrocaryum acaule*, Mart., etc.

HABITAT.—Same as the former, with fragments of large rays of *Sabal ?*, which measure four centimeters across (*Dr. F. V. Hayden*).

Palmocarpon commune, Lesqx.

Plate XIII, Figs. 4–7.

Carpolithes palmarum, Lesqx., Supplement to Annual Report, 1871, p. 13 (in part); Annual Report, 1872, pp. 382, 398.

Fruits large, orbicular when surrounded with the shelly exocarp, round-oval, slightly truncate on one end, broadly, obscurely pointed at the other, and very minutely and indistinctly veined when this envelope is destroyed.

These fruits, about three centimeters in diameter, and nearly globular

when covered with the outer envelope, are broadly oval and a little smaller, two and a half centimeters long, and two centimeters across when deprived of their exocarp. This shelly covering is thin, straw-colored or yellowish, smooth, and easily crushed, as represented in figs. 4 and 5; the endocarp appears also thin and, like the kernel, soft and easily yielding to compression; therefore few of these fruits are preserved in their original form. As seen in figs. 6 and 7, the endocarp is very thinly lined in the length, a character which is remarked only with the glass; and on one side they are indistinctly marked by scars resembling the point of a chalaza with the raphis and the hilum, as seen on the endocarp of some seeds.

At first, considering only the specimens of the Raton, deprived of their exocarp, and comparing them to the description of *Carpolithes lineatus*, Newby., in *Notes on the Later Extinct Floras*, I supposed that these species were perhaps identical. But after the examination of a number of fruits found at Evanston (represented in pl. lx, figs. 1 to 1 *d*), which are more distinctly related to Dr. Newberry's species, those described above were perforce recognized as referable to far different kinds of vegetables. They pertain to Palms by their form, their size, their double shelly pericarp, and, indeed, resemble the fruits of some species of *Iriartea*, *I. setigera*, Mart., for example; or of *Leopoldina*, like *L. pulchra*, Mart.. They are found very numerous in certain localities of limited areas, as if they were derived from a common support or a raceme. At least, the specimens of Golden and of the Raton are mixed with cylindrical fragments, like branches and branchlets, or clustered peduncles half destroyed by maceration, and to which these fruits seem to have been originally attached; even with pieces of textile filaments, like remnants of decomposed spathes.

HABITAT.—Raton Mountains (*Dr. F. V. Hayden*); Golden, very common, with fragments of *Sabal;* Black Butte, above main coal.

Palmocarpon truncatum, sp. nov.

Plate XI, Figs. 6-9.

Fruits subglobular, slightly flattened, truncate on one side, covered with a brownish, smooth, shelly envelope.

In regard to their size, these fruits represent two species. As their characters are, however, the same, and as the difference in size may result from the relative position upon racemes of the same species but of different age, I have considered them as varieties: var. *major* and var. *minor*.

The largest specimen of var. *major* (fig. 7) measures seventeen millimeters across, from side to side, and ten millimeters only from the truncate base to the top; one specimen, which seems intermediate between both varieties, is only fourteen millimeters broad and eight millimeters high. The shelly pericarp, of a darker color and smooth, is perhaps slightly stronger than in the former species; nevertheless, the specimens are generally crushed and flattened by compression. The var. *minor* (figs. 8 and 9) is represented by nutlets one centimeter across the widest part and five to six millimeters in the other direction, generally in a better state of preservation, but with the same thin pericarp of the same color. The characters of these small nuts refer them to *Sabal*, some species of which have racemes of fruits of the same form, surrounded with an outer envelope easily crushed and of soft texture. Figs. 8 and 9, for example, closely resemble the seeds of *Sabal Mexicana*, Mart. The connection of these fruits with fragments of leaves of *Sabal*, especially of *S. Campbellii*, seems also to point out their reference to species of this genus.

HABITAT.—Golden, Colorado; not as commonly found as the former.

Palmocarpon corrugatum, sp. nov.

Plate XI, Figs. 10 and 11.

Fruit hard, enlarged in the middle, truncate at one end, slightly narrowed and obtuse at the other, ribbed in the length, deeply rugose across.

This kind of nutlet seems, at least in fig. 11, to have its pericarp half destroyed by maceration; for fig. 10, which has the same characters, differing merely by its smaller size, has the epicarp smooth. The one (fig. 11) is marked in the length by ten narrow costæ, and across by deep irregular wrinkles. It is one and a half centimeters in diameter, and from the exact similarity of form I consider it as representing the same species as fig. 10. The relation, however, of these fruits to living species of Palms is as yet uncertain.

HABITAT.—Golden, Colorado; with the former.

Palmocarpon subcylindricum, sp. nov.

Plate XI, Fig. 12.

Fruit oblong or subcylindrical, truncate at one end, split at the other in two diverging or slightly recurved, pointed lobes, distantly and obscurely veined toward the base.

As seen from the figures, these fruits vary in size from ten to fifteen millimeters broad in the middle, though generally of about the same length, or two centimeters from the border of the truncate base to the points of the

lobes, which, in all the specimens obtained, are flattened. A number of these are crushed and disfigured by compression, and the splitting at the top might therefore be considered as casual or a result of mere mechanical agency. But I have carefully detached from the matrix some well-preserved nutlets, like those of fig. 12, and all have the top flattened and split, though they are cylindrical from above the middle to the base. I therefore consider this character as original, and indeed, but for this, these fruits should be referable to Oaks, their form being like that of species of acorns of the present flora; or to nutlets of *Nelumbium*, the Sacred Bean, which they also resemble. I believe, however, that they are referable to Palms. Their pericarp is of the same color and consistence as that of *Palmocarpon commune;* it is in the same way obscurely lined toward the truncate base as in *P. truncatum*, and the fruits are found mixed with the specimens of these two species, and also in connection with fragments of Palm or Sabal leaves. The truncate base is a character of the fruits of some species of Sabal.

HABITAT.—Golden, Colorado; Table Mountain.

DICOTYLEDONES.

Some of the fossil species of this division of the vegetable kingdom have been found in Europe with leaves and fruits in connection with stems and branches, even with flowers. In a few cases, therefore, an exact determination of these plants has become possible. But generally, and with scarcely any exception in this country, the fossil species of dicotyledonous plants are represented by their leaves only, and therefore their determination is subject to a degree of uncertainty. The leaves, however, afford distinct, even specific characters, by their form, their thickness, or consistence, especially by their nervation. A number of botanists of celebrity—A. P. De Candolle, Leopold de Buch, d'Ettingshausen, Heer, etc.—have attempted to determine by rules the essential characters of the nervation of the dicotyledonous leaves, and to represent them under peculiar names, in order to facilitate researches and the study of palæontology. Though the laws governing the distribution of the veins in the leaves in comparison to their forms have not yet been fully discovered, we have, in the description of our fossil leaves, to rely on and to describe all the characters which render them identifiable, and therefore to use all the materials obtainable for that purpose. The terminology serviceable for the description of the forms of the leaves is generally known by botanists,

or is found explained in text-books, especially in Gray's Lessons in Botany. But that which relates to nervation forms a separate section, considered only in works on vegetable palæontology, rarely accessible to the student. I therefore give herewith an abridged explanation of the terms which may be used in describing the American Tertiary plants in this memoir. For some authors, as for d'Ettingshausen, who has given to the subject a careful and long study, the groups fixed by the characters of the nervation are numerous, and their distinction is somewhat embarrassing in many cases. Heer's classification is by far the simplest, and more comprehensible. It has been admitted by many European authors, especially by Schimper in his Paléontologie Végétale. According to it, we have:—

1. LEAVES PENNINERVED.—These have a midrib, or primary nerve, branching on each side. These branches, the *secondary nerves*, have to be considered in their position, as alternate or opposite, in their respective distance, and especially in their angle of divergence, from the middle nerve and their direction toward the borders. Their branches are tertiary nerves, or veins, except when they join the secondary nerves, either immediately or by subdivisions, when they become *nervilles* or *veinlets.* When these veinlets are in right angle to the secondary or tertiary nerves, and pass across them, they are *percurrent nervilles;* when they are curved, or broken, or connected with veinlets of the same order, they become *inflected or broken nervilles.*

According to the distribution of the nerves, the surface of the leaves is divided in *areas* of different orders. Those which are limited on one side by the primary nerves, and fill the space between two secondary ones, are named *areas of the first order.* Those which are surrounded by secondary and tertiary veins are *areas of the second order.* When the veinlets divide in thinner branches, they surround *areolæ*, which may be subdivided by descriptions in *areolæ or meshes of the second, third, fourth order*, etc. Sometimes the primary areas are traversed, as in the leaves of Willows, by shorter secondary nerves, which soon divide into areolæ or join by their branches the secondary nerves of the first order. These are generally named *tertiary nerves*, or *shortened secondary*, or *pseudo-secondary nerves.* The areas of the different orders are often clearly defined, as in the leaves of the Maple, for example; but sometimes they gradually become undiscernible by the thinning of the veinlets, and lose themselves in the netting. In this case, the ultimate divisions are called *dissolved nervilles.*

Considering the secondary veins in relation to their mode of expansion into the leaves, they are named:—

1. *Craspedodrome*, when they reach and penetrate the borders in passing up from the middle nerve. The leaves with a nervation of this kind are more generally dentate or lobed. These nerves are either *simply craspedodrome*, when they join the borders without branching, as in the Chestnut, the Beech, etc., or *doubly craspedodrome*, when they branch and join the borders with all their divisions or some of them only, as in the Birch, the Hazel, the Elm, etc.

2. *Camptodrome*, when the primary areas which they limit do not reach to the borders. Then the nerves curve inside of the borders, and thus they inclose the outside borders of these areas. The secondary nerves either curve quite near the borders, and the veinlets which go out of the flexure immediately enter the margin, or the primary areas do not extend so far, the secondary veins curving and becoming united nearer to the midrib, and thus a series of secondary areas is formed between the borders and the bend of the secondary nerves by successive divisions; these are named *marginal areas*, and, when in many rows, may be distinguished as inner, middle, and outside areas. They may be named also, in considering especially the nerves, *festoons*, or *bows*, single or multiple, with the same appellation for their range, except for the border area, which is generally called *marginal*. When, by anastomoses, the veins form a series of meshes, which, distinct, decrease in size from the lower part of the areas to the borders, this nervation is named *brachiodrome*.

3. *Marginal nerves* are those which, going out from the midrib at the base of the leaves, follow close to the borders and parallel to them. They are not secondary nerves, for these, passing up along and from the midrib, join the marginal veins along the borders; they form a true border line, which generally curves inside at the point of union to the secondary veins. This nervation characterizes a large number of leaves, especially of the *Myrtaceæ*, the *Proteaceæ*, the *Myricaceæ*, etc. A fine representation of it is seen in *Myrica Torreyi* (pl. xvi, figs. 4, 8, and 9, of this volume).

4. *Mixed nerves* are seen upon leaves where the secondary nerves are on one part craspedodrome, while on the other they are camptodrome. This is often seen in lobate leaves, where some of the secondary nerves ascend to the point of the lobes, while, above it or under it, others curve along the borders, as in the leaves of the Tulip tree, for example.

5. A *hyphodrome nervation* is that of thick, coriaceous leaves, whose midrib only is strong and distinct, while the secondary nervation is indiscernible. In this case, the nervation is about like the reticulate one, which, however, has the second and tertiary veins about of equal thickness, distinct, united, forming a prominent netting.

6. The *acrodrome nervation* is that of the leaves with secondary nerves, all at an acute angle of divergence, curving along the borders, the upper ones passing up to the point of the leaves. Of this kind there are two divisions:—

a. When all the secondary nerves are of the same order, with the upper pair only ascending to the point of the leaves, as in the Dogwood;

b. When the two lower secondary nerves are stronger than those above them, ascend to the point, and branch outside, as in *Ceanothus Americanus*, the common Jersey Tea.

This subdivision makes a transition to the triple-nerved leaves.

2. Leaves palmate-nerved.—In this division, the primary nerves, three, five, even seven, go out together from the base of the leaves, or from a short distance above it, generally diverging fan-like, either all of the same thickness or the lateral ones of different thickness, as in some Poplar leaves. With palmate leaves, the areas are described as for the penninerved ones, the primary areas being limited between the primary and secondary nerves on both sides, and the name of *cardinal areas* being given to the large ones inclosed between the primary nerves on two sides and the borders on the other. The palmate-nerved leaves are subdivided also according to the characters of their nervation in—

1. *Craspedodrome*, with primary nerves going out to the borders:—

a. With secondary and tertiary nerves running also to the borders;

b. With secondary nerves camptodrome;

c. With the same in part camptodrome, in part craspedodrome (mixed).

2. *Camptodrome*, when the midrib only reaches the borders, and all the others curve along them, as in the Poplar.

3. *Acrodrome*, when the lateral primary nerves ascend to the point of the leaves.

3. Peltate-nerved leaves.—They have their primary nerves radiating all around the top of the petiole, which may be either central to the leaves, or on one side of them. The subdivisions have the same characters as those remarked above.

APETALÆ.

AMENTACEÆ.

MYRICACEÆ.

MYRICA, Linn.

This genus is now represented by about forty species, distributed over the whole world, with the exception of Australia. The continent of America has the largest number. Besides seven species belonging to the flora of the United States, ten others inhabit Mexico and the Pacific coast as far south as Peru. In Africa, the Cape of Good Hope has nine and Abyssinia one. Asia has six species between the tropic and the equator, two species being ascribed to Java. Cuba has two, Japan one, and Europe one, *Myrica gale*, indigenous also in this country. A peculiar section of the *Myricæ*, *Comptonia*, which had many representatives in the Tertiary floras, has only one species living, *M. Comptonia*, D. C., the well-known Sweet Fern, which exclusively belongs to the Atlantic slope of North America. The present distribution is worth remarking in comparison to what is known of the genus in the geological times, in order to come, if possible, to the solution of the question referable to the origin or dispersion of vegetable types.

The Cretaceous flora of North America has two species of *Myrica* recognized by their leaves, and one by seeds, the latter referable either to one of the two first species or representing a third. In Europe, two species also have been described by Heer from the Quadersandstein of Quedlinburg, Germany, and a third from the Upper Cretaceous of Greenland. Therefore the origin of the genus is positively recorded in the flora of the Cretaceous, and at this period its presence is about equally indicated in Europe and in this country. But ascending higher in the geological ages, we find forty species of *Myrica* described from the Lower Tertiary of Europe, half of them in the Eocene, the other part in the Paleocene, and more than forty species in the Miocene. From the Eocene, or Lower Lignitic, of the United States, we know as yet only two species of this genus, one of which is still of doubtful reference; and from the groups of Carbon and Evanston, considered as Upper Eocene and Miocene, we have none. It is only in the fourth group, that of the Parks and of Green River, that we find the genus represented by a proportionally large number of species, twelve, six of which are referable to the section *Comptonia*, which, in the European Tertiary, has twenty-three species.

Except for this last group, therefore, there is no relation whatever in the distribution of species of *Myrica* in both the Tertiary floras of Europe and of America; and if we are able to trace on this continent some analogy of distribution in the section of the *Comptoniæ* of the Upper Tertiary and of the present flora, there is evidently none of this kind in Europe.

Though the leaves of *Myrica* seem distinctly characterized, some of them, nevertheless, have in their form and nervation a degree of relation to those of *Proteaceæ*, of the genera *Dryandra* and *Lomatia* especially. Some paleontologists, d'Ettingshausen above all, have described a number of these leaves under the generic name of *Dryandroides* and *Lomatites.* Since then the seeds of some of those supposed *Proteaceæ* have been found, and their reference to *Myrica* is positive; and now the opinion is prevalent that, if not all, at least the largest number of these species belong to *Myrica.* Saporta, in considering this question in a geological point of view, hypothetically demands whether, as the *Myricæ* and the *Proteaecæ* have originated in the Cretaceous, and as there is now a kind of parallelism in some of their characters, seemingly recording a common birth, they could not have been at the outset identical in their generic characters, and have branched through the geological times into those two divisions, now so widely separated by some of their more important botanical characters, as by their geographical distribution. The celebrated author remarks on this subject that in the Cretaceous flora of Belgium, Debey and d'Ettingshausen find the *Myricæ* with the *Proteaceæ*, the first, however, in a very subordinate number, and that, from his own observations, the relative position of both these groups is remarked to be the same as high as the Gypses of Aix, when the *Proteaceæ* began to decline and the *Myricæ* to take the ascendency. On this subject, the little we know of the recent geological floras of this continent does not give any evidence for the solution of hypotheses of this kind. The *Proteaceæ* of the Dakota group (Cretaceous), *Proteoides* of Heer, are too indistinct in their characters to afford a reliable point of comparison. These leaves, known especially by their coriaceous consistence and their form, for the nervation is scarcely discernible, may represent a single species of plants of a group far different from that to which they are hypothetically ascribed. At any rate, in passing up to the Tertiary, we do not find any leaf comparable to any *Proteaceæ* except in the Lower Eocene, *Myrica Torreyi*, which resembles a *Lomatia* by its nervation, but with which seeds of *Myrica* have been found; and, in the

Upper Miocene, or fourth group, a very small leaf described as *Lomatia microphylla*, which even may belong to a species of *Myrica*. I have therefore until now considered as very doubtful the presence of true *Proteaceæ* in the geological floras of this continent, and for this reason I do not find any fact in support of the hypothesis of a common origin and parallel development of the *Myricæ* and the *Proteaceæ*. On the contrary, I believe that the deeper we go into the study of the fossil plants of North America, and the more intimately we become acquainted with the characters of the ancestors of our present flora, the greater will we find to be the analogy of the old types with the present ones, and that we shall see gradually disappear those foreign types bearing the so-called Austro-Indian and Australian characters. On the present subject, it seems established: that in Europe the *Myricæ* take a gradual and considerable importance during the whole Tertiary period, and then nearly entirely disappear from the flora of that continent. Until now, no species of this genus is described from the Pliocene. And per contra: that in North America the representation of this group of plants is scanty from the Cretaceous up to the Upper Miocene, where it takes that higher degree of predominance which is preserved, it seems, in our present flora.

I have formerly considered as referable to *Myrica* a fragment of a leaf, remarkable indeed for its size, as a representative of a genus whose leaves now are all of a comparatively small size. This leaf is by its form and nervation in exact concordance of characters with those of *Comptonia*, as seen from pl. lxiv, fig. 1. The fragment is already much larger than Unger's *Myrica grandiflora*, considered till now as the giant of the genus, and therefore its relation is contested on that ground. Now, the discoverer of this fine specimen, taken from a shaft sixty feet deep, asserts that he has seen at the same place leaves of the same kind of a far larger size, some of them about ten feet in length. If so, we should have to look to another group of plants for the relation of these leaves. I must, however, remark that, contrary to what is asserted by some paleontologists, the Tertiary leaves are generally of a diminutive size in comparison with those of the flora of our time. The size seems greatly exaggerated to the eyes by the fossilization, or the flat position of the leaves upon stones, and is therefore considerably reduced by measurements. The largest fossil dicotyledonous leaf which I have ever seen is that of an *Aralia*, from the Upper Miocene of California, appearing indeed of a monstrous size. It measures twenty-seven centimeters

across the point of the outer lobes. Now, I have a leaf of *Aralia papyracea* of Japan, which closely resembles the fossil species, and which I selected of the smallest possible size, in order to have it in herbarium. It measures fifty-eight centimeters across, also from the point of the lobes. The largest leaves of *Platanus nobilis*, twenty centimeters broad, and of *P. Haydenii*, Newby., sixteen centimeters across the lobes, are of the largest and finest obtained fossil specimens. Leaves of our *Platanus occidentalis*, thirty centimeters broad, are not rare. Of living Magnolia, the leaves measure as high as thirty centimeters long and fourteen centimeters broad; the Papaw, when growing under the shade, has still larger leaves, thirty-two centimeters by fifteen, and so on. As yet I have not seen, except for this *Myrica*, any fossil leaves of a size superior to those of the present flora in comparing specimens of the same generic type. This case would therefore look like an anomaly, and suggest the probability of a different relation. I should have admitted this view, if, in the original determination of this species, I had not had for point of comparison *Myrica* (*Comptonia*) *grandifolia*, Ung. (Fl. of Sotzka, p. 31, pl. viii, fig 1), whose preserved fragment, the upper part of a leaf only, measures fourteen centimeters long and five centimeters broad, while a whole and large leaf of the living *Comptonia asplenoides* is only seven centimeters long and one centimeter broad. As there are some species of the same group with leaves intermediate in size, *M. hakeæfolia*, Sap., *M. insignis*, described here below, etc., I cannot see in the difference of size a sufficient reason to separate from this genus a leaf which by its other characters seems evidently referable to it.

§ 1.—*Leaves entire, undulate, or dentate.*

Myrica Torreyi, Lesqx.

Plate XVI, Figs. 3–10.

Myrica Torreyi, Lesqx., Annual Report, 1872, p. 392.—Schimper, Pal. Végét., iii, p. 586.

Leaves membranaceous, narrowly lanceolate, tapering up to a long linear acumen, gradually narrowed to a short broad petiole, distantly dentate; nervation marginal.

The leaves are variable in size, from four to fifteen centimeters long, including the petiole, and from eight to thirty millimeters broad below the middle. Gradually decreasing upward to a long narrow acumen, they are more rapidly narrowed to a short, broad, sometimes half-winged, petiole. Their nervation is marginal, a distinct though narrow vein following up quite near the borders, where it is joined by the secondary nerves, simple or branching, and slightly bending inward at the point of

connection. The secondary veins are united by cross-nervilles in right angle, forming large quadrate areolæ; the ultimate nervation being obsolete. The borders, irregularly and obtusely dentate from a little above the petiole, become entire from the base of the long acumen up to its point. In the numerous specimens obtained of this species, and those examined *in situ*, I have seen the acumen of the leaves preserved, and measuring one to three centimeters, linear, entire, gradually sharply pointed. The divergence of the secondary veins is about 60°. By the form of the leaves and the slightly obtuse teeth of the borders, this species is like *Banksia Ungeri*, Ett., described in Här., Fl., p. 54, pl. xvii and xviii, as *Myrica banksiæfolia*, Ung. Its nervation, however, relates it very intimately to *Lomatia latior*, Heer, Balt. Fl. p. 80, pl. xxiv, fig. 16. The fragment figured by Heer is regretably too small for a close comparison. It seems, however, remarkably like our fig. 9, base of fig. 8, both by the nervation and the denticulation of the borders. Species of the same type are described from Sotzka and Mount Balca, or from the Eocene. I cannot consider these leaves as referable to a species of *Lomatia*, for the reason that the shaly sandstone where they abound have also numerous scattered seeds and scales like those of *Myrica*. They are figured in pl. lx, fig. 3, and described hereafter as *Carpolithes myricarum*.

HABITAT.—Black Buttes, Wyoming Territory, in soft sandstone above main coal; also in the burned red shale top of the hills.

Myrica acuminata, Ung.

Plate XVII, Figs. 1–4.

Myrica acuminata, Ung., Flor. of Sotzka, p. 30, pl. vi, figs. 5–10; pl. vii, fig. 9.—Heer, Fl. Foss. Arct., i, p. 102, pl. iv, figs. 14–16; pl. vii, fig. 6 *b*; Mioc. Balt. Fl., p. 33, pl. vii, fig. 1; Fl. v. Bornst., p. 13, pl. ii, fig. 1.—Lesqx., Annual Report, 1873, p. 411.

Dryandroides acuminata, Ett., Proteac. d. Vorw., p. 32.—Heer, Fl. Tert. Helv., ii, p. 103, pl. xcix, figs. 17–21; pl. c, figs. 1–2.

Leaves coriaceous, shining, linear-lanceolate, acuminate, irregularly dentate; nervation obsolete.

Variable in size, from four to eight centimeters long, and comparatively narrow, these leaves are linear-lanceolate, gradually tapering upward and acuminate, more rapidly narrowed to a short petiole, irregularly sharply dentate on the borders. Their consistence is coriaceous, the surface shining, and the nervation obsolete, at least toward the borders, where the veins seem directed to the teeth, but not entering them. Unger says of the leaves of his species: *serraturis equalibus, minimis, approximatis*, a character which does not seem to be in accordance with what is represented in figs. 1 and

4 of our plate, however agreeing with the denticulation of the leaves in figs. 2 and 3. This appears to be a mere variation; for the specimens sent for determination are numerous, and show many differences in the forms of the leaves and the denticulation of the borders, even upon the same leaf; one of them, for example, represents a long acuminate leaf, with equally serrate borders on one side, while on the other the teeth are close and unequal. As the specimens from one of the localities mentioned below have much smaller leaves, shorter and narrower than those described from Europe, ours may represent a different species. Saporta considers it as rather allied to *M. arguta*, Heer, and *M. Zacchariensis*, Sap., both Miocene.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*). One mile west of Florissant, Colorado (*Dr. A. C. Peale*). Mouth of White River, Utah (*Prof. W. Denton*).

Myrica Copeana, Lesqx.

Plate XVII, Fig. 5.

Myrica Copeana, Lesqx., Annual Report, 1873, p. 411.

Leaves lanceolate, taper-pointed, rounded to the base, deeply doubly serrate; nervation penninerve, craspedodrome.

A fine leaf, of which there is only one specimen, about eleven centimeters long (the point and base are destroyed), three and a half centimeters broad below the middle, lanceolate, gradually acuminate, rounded or truncate to the base, doubly serrate, with sharp long teeth turned up, and alternate smaller ones, the first entered by the secondary veins, the others by their branches or by thinner shortened secondary ones. The lateral nerves are, near the base, nearly at right angle to the midrib, and some of them branching once; the upper veins at a more acute angle of divergence are all simple, and the border teeth become simple also and equal. The areolation mostly obsolete, discernible only at a few places, where a thin coating of coaly matter covering the surface is erased, is in small quadrangular meshes, oblique to the secondary nerves. The consistence of the leaf is not very thick, not coriaceous. This species is distantly comparable to *Myrica Græffii*, Heer, Fl. Tert. Helv., iii, p. 176, pl. cl, figs. 19, 20.

HABITAT.—Near Florissant, Colorado (*Prof. E. D. Cope*).

Myrica undulata?, Heer.

Plate XVII, Figs. 6–8.

Myrica undulata, Heer, Fl. Tert. Helv., iii, p. 188, pl. cliii, figs. 21–22.—Lesqx., Annual Report, 1873, p. 412.

Leaves subcoriaceous, ovate-lanceolate or linear-lanceolate, acuminate, narrowed to a short petiole; borders regularly and deeply undulate; nervation camptodrome.

Leaves variable in size, about five centimeters long, one to two centime-

ters broad, linear-oblong or ovate, acuminate, narrowed in a curve to the short petiole; borders more or less deeply, regularly undulate; secondary veins curving near the borders, joining the midrib at a more or less acute angle of divergence according to the width of the leaves, with shortened ones between them; fibrillæ slightly oblique or nearly at a right angle to the veins; areolation irregularly quadrangular. From the first specimen which I had for examination (fig. 8), I considered the leaf as positively referable to that of Heer; but from the comparison of other and more perfect specimens, the leaves seem to differ, not only in their more enlarged size, but in the nervation, the secondary veins being closer, more regularly parallel, separated generally by dissolved intermediate ones, and the areolation more distinctly quadrangular. Heer also describes his species as coriaceous. These leaves of ours are not quite coriaceous, though somewhat thick; their identity with the European species is therefore doubtful. In comparing *M. undulata* to his *M. obtusiloba*, represented in pl. lxx, fig. 10 (*loc. cit.*), Heer remarks, as essential difference, the thickness of the midrib in this last species. By this character, the leaf of our fig. 8 is identified with *M. undulata*, while by its nervation, close secondary veins, and intermediate shorter ones, as also the linear shape, it is more distinctly allied to *M. obtusiloba.*

HABITAT.—Elko, Nevada (*Prof. E. D. Cope*).

Myrica nigricans, Lesqx.

Plate XVII, Figs. 9–12.

Myrica nigricans, Lesqx., Supplement to Annual Report, 1871, p. 6.

Leaves nearly sessile, alternate, oblong or linear-lanceolate, acuminate, rounded-cuneate to the base, obtusely dentate; nervation camptodrome.

The leaves of this species are much like those of the former, only narrower, all narrowly lanceolate or linear-lanceolate, narrowed to a long acumen, and about sessile or with a very short petiole about one millimeter long. They are more or less unequal at the base, distantly obtusely dentate in the middle, with a nervation of the same character as that of the former species, or like that of the living *Myrica Californica* or *Myrica gale.* The substance of these leaves is not coriaceous; but all the fragments are blackened on their surface, and apparently dotted with oil-points, as in the common *Myrica cerifera.* This color renders them easily discernible upon the yellow soft sandstone of the locality.

HABITAT.—Green River, Wyoming, northwest of the station, above fish-bed (*Dr. F. V. Hayden*).

Myrica Bolanderi, Lesqx.

Plate XVII, Fig. 17.

Ilex undulata, Lesqx., Annual Report, 1873, p. 416.

Leaf oblanceolate, obtusely pointed, dentate at the top; secondary veins camptodrome.

A single leaf, about six centimeters long, one and a half centimeters broad toward the point, coriaceous, obtuse, and obtusely pointed at the top, which is marked by a few teeth on each side, entire downward, and gradually decreasing to a broad, winged(?) petiole (broken); middle nerve narrow; secondary nerves at irregular distance and on an acute angle of divergence, thin, camptodrome; areolation obsolete.

Though this leaf recalls by its form and texture species of *Ilex* of the present time, some of its characters, the enlarged base of the leaf, the narrow middle nerve, the disposition of the secondary veins, seem to refer it more probably to this genus.

HABITAT.—Locality unknown. Check-number H 1295, sent with specimens from Castello's Ranch, Colorado, and apparently from the same place (*Dr. F. V. Hayden*).

Myrica Ludwigii, Schp.

Plate LXV, Fig. 9.

Myrica Ludwigii, Schp., Pal. Végét., ii, p. 545.
Myrica longifolia, Ludw., Palæont., viii, p. 94, pl. xxviii, figs. 8, 9; xxix, figs. 1, 3, 5, 6, 7; xxx, figs. 1, 19; lx, fig. 15.—Lesqx., Annual Report, 1874, p. 311.

Leaves of middle size, subcoriaceous, linear-lanceolate, gradually tapering into a long entire acumen, distantly deeply dentate in the middle; midrib thick; secondary veins subopposite, open, parallel, curved in passing to the borders, camptodrome.

This leaf, of which we have only the uppor part, a little more than one-half, seems evidently referable to the European species described from a large number of specimens; the form of the leaf, with its long acuminate entire point, corresponds to that of Ludwig (*loc. cit.*, pl. xxviii, fig. 8); the midrib is somewhat broader in the American specimen, and the secondary veins at a slightly more acute angle of divergence; but these characters are reproduced in the leaves figured by the German author, the broad midrib in fig. 1 of pl. xxix, and the more oblique secondary veins in pl. xxx, fig. 1. As far as it is seen upon our fragment, whose areolation is obsolete, the details of nervation have the same characters, the secondary veins curving along the borders, and the teeth being entered only by veinlets outside of the primary areas. As remarked by Schimper, this species goes to the same group as *Myrica acuminata*, etc., its nearest relation among the living species being *M. cerifera*,

L., of North America. The fragment indicates a leaf membranaceous or rather subcoriaceous.

HABITAT.—Green River group, near the mouth of White River, Utah (*Prof. W. Denton*).

§ 2.—*Leaves pinnately lobed.*

COMPTONIA.

Myrica latiloba, Heer, var. acutiloba.

Plate XVII, Fig. 13.

Myrica latiloba, Heer, Flor. Tert. Helv., iii, p. 176, pl. cl, figs. 12–15.
Myrica latiloba, var. *acutiloba*, Lesqx., Annual Report, 1873, p. 412.

Leaf membranaceous, oblong-lanceolate, cuneate at the base to a comparatively long slender petiole, pinnately divided in short angular acute lobes; secondary veins distinct, open, mixed.

This leaf has from the base to the middle, where it is broken, the same character as those described by Heer, it being apparently short, abruptly narrowed to the point. As the nervation is of the same character, the lower secondary veins very open, camptodrome, the upper ones at a more acute angle of divergence and entering the teeth or craspedodrome, and intermediate, short, very thin; secondary veins, soon dissolved into the reticulation, there is no appreciable difference but the acute lobes. Even this may be casual and unimportant, for in figs. 12 and 13 of Heer (*loc. cit.*), the lowest lobes are mere acute teeth, and, in our figure, the upper ones are apparently obtuse, though very short. I am the more inclined to consider this leaf as a mere variety of the European species, that I have from the Miocene of Oregon, John Day Valley, near Bridge Creek, a specimen of a leaf preserved in its integrity, and exactly concording in all its characters, even the size, with Heer's species.

HABITAT.—Florissant, near Middle Park, Colorado (*Dr. F. V. Hayden*).

Myrica partita, Lesqx.

Plate XVII, Fig. 14.

Myrica partita, Lesqx., Annual Report, 1873, p. 413.

Leaves subcoriaceous, narrow, linear, alternately equally divided to the middle nerve into equal, broadly lanceolate, acuminate lobes, slightly denticulate on the lower borders; secondary veins three in each lobe, parallel, the upper one longer, passing up to the point of the lobes, the lower ones to the teeth.

A mere fragment, too small to indicate satisfactorily the characters of the leaf. It is comparable to the species of *Myrica* whose type is *M. Œningensis*, Al. Br., which are common in the Miocene of Europe. But for the small denticulation of the borders, it would be identical with *M. incisa*, Ludw. (Paleont., viii, p. 96, pl. xxx, figs. 7–15). This difference is an important

one, as most of the species of fossil *Comptonia* have their lobes entire. *M. Matheroniana*, Sap., of the Armissan of France, has its lobes somewhat denticulate toward the point.

HABITAT.—Elko, Nevada (*Prof. E. D. Cope*).

Myrica Brongniarti?, Ett.

Plate XVII, Fig. 15.

Driandra Brongniarti, Ett., Foss. Fl. von Här., p. 55, pl. xix, figs. 1–26.
Myrica Brongniarti?, Lesqx., Annual Report, 1873, p. 412.

Leaf linear, pinnately divided into short, slightly obtuse lobes; nervation obsolete; secondary veins craspedodrome.

This fragment is still too incomplete for a satisfactory determination. The leaf is coriaceous, the details of nervation obsolete, and by its lobate borders it is intermediate in characters between the leaves described as *Driandra Brongnarti*, Ett. (*loc. cit.*), especially like fig. 20, and those of *Myrica ophir*, Ung. (Fl. v. Sotzka, p. 30, pl. vi, figs. 12–16).

HABITAT.—Elko, Nevada (*Prof. E. D. Cope*).

Myrica insignis, Lesqx.

Plate LXV, Figs. 7, 8.

Myrica insignis, Lesqx., Annual Report, 1874, p. 312.

Leaves large, membranaceous, narrowly oval or oblong, acuminate, narrowed to the base, pinnately lobed; lobes short, deltoid, acute, turned upward; middle nerve thin; secondary veins open, parallel, alternately passing up to the point of the lobes or to the base of the sinuses; areolation large, polygonal.

The two fragments of this beautiful leaf sufficiently represent its characters. The size is about ten centimeters long, nearly four centimeters broad in the middle, where the lobes are equal, divided to about one-third of the space between the middle vein and the borders, the two upper pairs being much shorter and longer, and the terminal one sharply acuminate, two centimeters long. As far as it can be seen at the base of fig. 7, the lower lobes are rapidly diminishing in size downward, and the lowest one is narrowed downward and slightly decurrent to the petiole. The nervation is perfectly distinct; the secondary veins, on an open angle of divergence of about 60°, mostly parallel, are mixed, the principal ones passing up in a slight curve to the point of the lobes; the others, quite as thick, going up to the base of the sinuses, where they divide into two branches, curving and anastomosing along each border, with fibrillæ, which, broken and branching in the middle of the areas, form large quadrate or irregularly polygonal areolæ. This nervation has the true character of that of the *Comptoniæ*, but no fossil species offers a point of comparison for this one.

HABITAT.—Florissant, Colorado (*Dr. F. V. Hayden*).

Myrica? Lessigii, Lesqx.

Plate LXIV, Fig. 1.

Myrica? Lessigii, Lesqx., Annual Report, 1874, p. 312.

Leaf coriaceous, very large, oblong in outline, deeply pinnately lobed; lobes opposite, ovate-lanceolate, taper-pointed, slightly broader in the lower part, at an open angle of divergence, separated to near the midrib, where they are joined in broad obtuse sinuses; middle nerve very broad; secondary veins proportionally thick, mixed.

If the leaf represented by the figured fragment does belong to the *Comptoniæ*, it is indeed of an enormous size, for the preserved part, which seems to be one-half of the leaf only, is twenty-two centimeters long, and the lobes, from the middle nerve to the top, measure more than nine centimeters, showing the width of the leaves to be at least eighteen centimeters. The midrib is very thick; the secondary nerves are of two orders: those of the first are strong, ascend to the point of the lobes, and branch on each side; those of the second are narrower, and come out of the middle nerve also. They are either short, passing up to the base of the sinuses, there diverging on each side, and following the borders in festoons, anastomosing with fibrillæ, or longer, traversing the large areas between the base of the secondary veins and the borders of the lobes, dissolving either in branches or fibrillæ, in right angle, as in the former species, which it much resembles by the characters of the nervation. The ultimate areolation is formed, as represented in the middle of the lower lobe of the figure, by subdivision nearly in right angle of the primary areolæ, in a very small quadrangular or polygonal reticulation.

Though the characters of nervation are those of *Comptonia*, remarkably similar indeed to those of *Myrica* (*Comptonia*) *Matheroniana*, Sap. (Ét., ii, 2, p. 93, pl. 5, fig. 7), beautifully represented in the enlarged figure (7 *a*), it is difficult to suppose a leaf of this genus as large as the one represented here. I have already explained what reasons induce me to describe it in this section. The celebrated author of the *Études*, quoted above, objects to this reference, and considers the fragment as part of a leaflet of some kind of *Araliaceæ*, like *Aralia multifida*, Sap. (Ét., i, 1, p. 115, pl. xii, fig. 1), a leaf palmately divided nearly to the top of the petiole in nine-lobed leaflets, varying from six to twelve centimeters long. The mode of division of these leaflets has indeed some likeness to that of our fragment, but the characters of nervation are somewhat different. I am unable to decide the question, from want of materials for comparison. The consistence of this leaf seems to have been hard, thick, and membranaceous at the same time, the nervation being clearly defined in black lines upon the brown color of the specimen.

I have lately received, from Rev. A. Lakes and from Golden, a number

of specimens, mostly fragments of leaves, which represent a species intermediate, by its characters, the form, and the size, between this and the former. The nervation is of the same type. These fragments show such an intimate relation between *M. Lessigii* and *M. insignis* that both appear necessarily referable to the same generic division.

HABITAT.—Coal Creek, Colorado, in clay overlying coal, reached by a shaft sixty feet deep (*Gen. W. H. Lessig*).

BETULACEÆ.

BETULA, Linn.

The distribution of this genus is limited at our epoch to the northern regions of Asia, Europe, and America, a few of its species ascending to the Arctic zone. Of the twenty-nine species described in the Prodromus of De Candolle, eight inhabit North America, four of them exclusively belonging to its flora. The numerous species of *Betula* described from the Tertiary of Europe, thirty-nine, are especially related to the present North American forms, as are also the few recognized in our geological formations.

The generic type appears to have originated in the Cretaceous period; for we have already two species described from the Dakota group formation: *Betulites denticulata*, Heer; *Betula beatriciana*, Lesqx. The genus is represented also in the Eocene of Europe by three species, two of them in the flora of Sézane; by four in the Paleocene, and thirty in the Miocene. Of these, of course, a large number are uncertain, the specific determinations from leaves only being perhaps more unreliable for this genus than for any other. In this country, one leaf only has been found in the lignite of Golden, doubtfully referable to *Betula gracilis*, Ludw., which by itself is already of uncertain relation, the only leaf which represents it being related to *Populus* rather than to *Betula*. Therefore we do not have as yet any positive record of this genus in the North American Lower Eocene. It is present, however, at Evanston, or in Upper Eocene, by two species, one of them new; also at Fort Fetterman, a Miocene formation, where some leaves of a new species have been found in connection with a profusion of remains of *Taxodium miocenicum*.

Betula Vogdesii, Lesqx.

Plate XVII, Figs. 18, 19.

Betula Vogdesii, Lesqx., Annual Report, 1874, p. 312.

Leaves small, thin, oval, acutely pointed, narrowed, and rounded to the petiole, minutely serrulate, penninerve; lateral veins parallel, opposite at or near the base, simple or the lowest ones sparingly branching, craspedodrome.

These leaves vary in size from three to four centimeters long and from

sixteen to twenty-five millimeters broad in the middle; their form is nearly oval, more enlarged, and rounded at the base, which seems to pass down abruptly from near the petiole as decurring to it; they are minutely apiculate and serrulate. The species is related by the nervation to *B. denticulata*, Goepp., (Schoss. Fl., p. 12, pl. iii, figs. 14, 15), a species considered by European authors as identical with *B. caudata*, Goepp.

HABITAT.—Fort Fetterman, Indian Territory (*Lieut. Vogdes*).

Betula gracilis?, Ludw.

Plate XVII, Fig. 20.

Betula gracilis, Ludw., Palæont., viii, p. 99, pl. xxxii, fig. 4.—Lesqx., Annual Report, 1873, p. 398.

Leaf small, ovate, obtusely pointed, distantly serrate; middle nerve thick; secondary veins mixed, some of them passing up in a curve to the teeth, simple.

The form of the leaf is ovate, apparently rounded at the base, which is destroyed; the secondary nerves, simple and curved in passing up to the borders, have the same character as in Ludwig's figure (*loc. cit.*), being, however, less distinctly camptodrome, and more generally running to the point of the small distant obtuse teeth. The European species is already of doubtful reference as remarked above, and therefore this fragment of a leaf is still more uncertain in its determination.

HABITAT.—Golden, Colorado.

Betula Goepperti, Lesqx.

Plate XVII, Figs. 21-23.

Betula caudata?, Goepp.—Lesqx., Annual Report, 1871, p. 293.

Leaves large, ovate, subcordate or rounded at the base, lanceolate-acuminate; borders irregularly crenato-serrate; secondary nerves half open, subcamptodrome, thin, joined by close nervilles in right angle.

These leaves are referable to Goeppert's species by their form, their size, and their nervation; the acumen is also generally inclined on one side, as in the European species. But, as remarked from a number of specimens, with borders more distinctly preserved, they have the teeth of the borders of a different character, not turned out and spinulose, but inclined upward and rather obtuse, as seen in fig. 23 *a*, enlarged. The veins, whose angle of divergence is 30° to 40°, are obsolete toward the borders, appearing either to enter the points of the largest teeth, or to be effaced and lost in the areolation, which is obsolete. As seen in fig. 21, the lower veins are opposite.

HABITAT. Evanston, Wyoming, where *Dr. A. C. Peale* collected the first specimens.

Betula Stevensoni, Lesqx.

Plate XVIII, Figs. 1-5.

Betula Stevensoni, Lesqx., Annual Report, 1871, p. 293; 1872, pp. 386, 401.

Leaves of medium size, ovate, tapering or rounded to an obtuse point, subcordate at the slightly unequal base, short-petioled, serrulate; nervation craspedodrome.

The leaves, varying in size from four to seven centimeters long and three to four centimeters broad, are ovate, round-pointed, serrate, with equal short teeth (fig. 3, enlarged); a half-round or subcordate base, and a short petiole; the secondary veins, six to eight pairs on each side, opposite, at or near the base, pass up to the borders nearly straight, scarcely branching under an angle of divergence of 40°, joined nearly at right angle by strong curved nervilles, interrupted by the veins. I found at Evanston, in connection with these leaves, a few bracts of cones of *Betula*, one of them similar to that figured by Heer (Fl. Arct., pl. xxv, fig. 25), which the author refers to *B. prisca.* Another, with three short-pointed divisions, appeared of the same character as that of fig. 30 (*loc. cit.*), named *Betula Forshammeri.* One of them or perhaps both forms may belong to our species, whose leaves are abundant at the same locality.

HABITAT.—Evanston, Utah; Carbon, Wyoming.

ALNUS, Tournef.

As seen in the supplement to the Cretaceous Flora of Nebraska, in Dr. Hayden's Annual Report for 1874, p. 355, the two forms of leaves previously referred in the Cretaceous Flora, p. 62, to *Alnus* and *Alnites* are considered by Saporta as rather referable to *Hamamelis* than to *Alnus*, and have been accordingly described in that supplement under the generic name of *Hamamelites.* At the same time, another leaf of *H.* (*Alnus*) *Kansaseanus*, found in a better state of preservation, has been represented in pl. vii, fig. 4, of that same supplement. The reference indicated by the name of *Hamamelites* is, however, quite as uncertain as that to *Alnus*, the more so that it is not confirmed by paleontological records; for, in the lowest Eocene of Point of Rocks, a species of *Alnus* or *Alnites* has been discovered, while as yet no species of *Hamamelis* has been found in the North American Tertiary flora, and none also in that of Greenland. The same can be said of the Tertiary flora of Europe, where one species only, doubtfully referable to

Hamamelis, is described in the Eocene Flora of Sézane. Considering, then, the geological records in regard to the present distribution of species in the North American flora, it would be more rational to refer to *Alnus* those Cretaceous leaves, and to regard the origin of this genus as Cretaceous.

The paleontologists of Europe have to the present time described twenty-nine species of *Alnus*, seven from the Lower Tertiary (Eocene and Oligocene), and twenty-two from the Miocene formations. We have as yet only five species referred to this genus, one from the Lower Eocene, and four from the Miocene; of these, one is described by Dr. Newberry from the Fort Union group, and two have been found in the Miocene of California and Oregon. This apparent difference in the distribution of this genus is ascribable to our limited acquaintance with the North American Tertiary floras

At the present time, fourteen species of *Alnus* are known and scattered over the boreal hemisphere, except two inhabiting the mountains from South Mexico to Chili. Two species are predominant in Europe, one south along the Mediterranean shores from Italy to the Caucasus, another a northern one, which also goes eastward to Western Asia; two others are still found in Europe, more rarely, however, and none exclusively limited to that continent. North America has five species, two of which exclusively belong to its flora, one from the western slope, the other from the eastern slope only. This distribution is therefore in accordance with that indicated by the Tertiary flora of this continent, while it is the contrary for Europe, which counts twenty-eight species in its Tertiary, and has none at our time exclusively pertaining to its flora.

Alnus Kefersteinii, Göpp.

Plate XVIII, Figs. 6–8; Plate LXIV, Fig. 11.

Alnites Kefersteinii, Göpp., Nov. Act. N. C., xviii, 1, p. 364, pl. xli, figs. 1–19.

Alnus Kefersteinii, Ung., Chlor. Protog., p. 115, pl. xxxiii, figs. 1–4.—Heer, Fl. Tert. Helv., ii, p. 37, pl. lxxi, figs. 6, 7.—Ludw., Palæont., viii, p. 97, pl. xxxi, figs. 1–5, xxxii, figs. 1, 2.—Ett., Foss. Fl. v. Bil., p. 47, pl. xiv, figs. 17–20.—Heer, Fl. Foss. Arct., ii, p. 146, pl. xxv, figs. 4–9; Fl. Foss. Alask., p. 28, pl. iii, figs. 7, 8; Mioc. Balt. Flor., p. 67, pl. xix, figs. 1–13.—Lesqx., Annual Report, 1871, p. 292; 1872, pp. 386, 401, 405.

Leaves of medium size, ovate, obtusely pointed or acuminate, rounded-subcordate at base, simply or doubly serrate; lateral nerves and their divisions craspedodrome.

The leaves of this species are very variable, especially in the denticulation of the borders. The most common variety is that represented in pl. xviii,

figs. 6–8, with borders doubly serrate, the teeth being small and sometimes obsolete. This is the form recognized in the Miocene of Alaska, Greenland, and the more common in Europe. The base of the leaves is rounded-subcordate, the lower secondary nerves more or less branching The other variety, a fragment of which is represented in pl. lxiv, fig. 11, has the borders either simply serrate or with a few irregular, large, more acute teeth; all the teeth, however, being larger and more obtuse than in the former variety. The characters of the nervation are the same as seen in the figure; the leaves are obtusely pointed, not acuminate. By its larger obtuse teeth, the leaf is more intimately related to *Alnus nostratum*, Ung., as described by Ludw. (Palæont., p. 98, pl. xxxi, fig. 8). But this last species has the leaves rounded at the top, and those of *A. Kefersteinii*, represented in Fl. Balt., *loc. cit.*, especially fig. 9, agree entirely, in their form and the denticulation of the borders, with the fragment under consideration.

HABITAT.—Evanston, Wyoming; not rare The fragment represented on pl. lxiv, near Florissant, South Park, Colorado (*Dr. F. V. Hayden*). Nine miles southeast of Green River, Wyoming (*Wm. Cleburn*).

Alnites inæquilateralis, Lesqx.

Plate LXII, Figs. 1–4.

Alnites inæquilateralis, Lesqx., Annual Report, 1874, p. 307.

Leaves rather thin, apparently membranaceous, very variable in size and form, broadly oval, obtuse or obtusely acuminate, rounded to the short petiole, distantly crenato-serrate; lateral nerves curving to the borders, either entering the teeth by their ends, or passing under them to follow the borders in simple festoons, joining the teeth by small branchlets.

The leaves vary in size from four to eight centimeters long and from three to six broad, one of the sides measuring generally one-fourth in width more than the other. The irregularity in the number of the veins is correspondingly great; one of the leaves, the smallest (fig. 4), for example, having six lateral veins on the left side, the lower much branched, while the other side has ten, all simple. There are a number of fragmentary specimens of the largest-sized leaves, like figs. 1 and 2, and these appear all related by their outlines and the nervation to *Populus Lebrunii*, Wat., a species which Saporta considers identical with his *Alnus cardiophylla*, Séz. Flor., p. 55, pl. iv, fig. 9, and pl. xv, fig. 8. This last figure especially is much like fig. 1 of our plate, merely differing by the form of the teeth, which, in the American species, are broader and more obtuse. In this also the nervation is more distinctly pennate, and the disposition of the veins to enter the teeth by their

extremity is more marked. The inequilateral shape of the leaves and the irregularity of nervation are not of frequent occurrence in the living species of *Alnus;* these characters are seen, however, in the leaves of a number of fossil species, like *Alnus cycladum*, Ung., *A. sporadum*, Sap., *A. cardiophylla*, etc.

HABITAT.—Alkali Station, Wyoming (*Wm. Cleburn*).

CUPULIFERÆ.

OSTRYA, Michx.

By their form and nervation, the leaves of this genus resemble those of *Carpinus* and *Betula.* The teeth of the borders are smaller than those of *Carpinus*, and they do not bear any secondary teeth upon their anterior face. As yet, we have no fossil remains referable to this genus in the North American fossil floras. The capsule of the fruit, which is veined in its length and vesicular, is easily recognized, though the leaves may not be distinct from those of *Carpinus.* In the European Tertiary Flora, the genus *Ostrya* is represented by six species, one of them Eocene, another of doubtful reference; the others all Miocene. The present flora has only two species, one eastern, in southern Europe, extending from France to the Lebanon Mountains; the other, *O. Virginica*, exclusively belongs to this continent, having also a wide range of distribution, or from New Brunswick to Lake Winnipeg, in 30° of longitude, and from 55° of latitude north to 20° in Mexico, where the species has been found near Jalapa, and still more south, in the mountains of Orizaba. It is, therefore, probable that one species, at least, of *Ostrya* may be found in the American Tertiary.

CARPINUS, Linn.

The geological distribution of this genus does not agree in Europe and in North America, as far as we know it, at least. While here two species only are known by their leaves, from specimens obtained in the Upper Miocene of the Parks, the paleontologists of Europe have described seventeen species from leaves, and eight from the fruits or from involucres. It is probable, as Schimper supposes, that a number of these species will have to be eliminated by more careful researches. However, the predominance of this genus is marked in a high degree in Europe in comparison to what it is here. The genus appears already in the Eocene of Sézanne by the leaves of two species; the others are Miocene; only one is referred to the Plio-

cene. Of the five living species of *Carpinus*, one is now found in Europe, passing east into Asia, following about the same geographical distribution as *Ostrya carpinifolia*. One also, *C. Americana*, is exclusively limited to the North American continent, having apparently the same range as *Ostrya Virginica*, of which it is a constant associate. It ranges toward the north as far as Lake Superior, and its presence is recorded in Florida by Chapman. Gray, in his Statistics of the Flora of the Northern States, places it in the list of the species which range through 15° to 19° of latitude.

Carpinus grandis, Ung.

Plate XIX, Fig. 9; Plate LXIV, Figs. 8–10.

Carpinus grandis, Ung., Sillog., iii, p. 67, pl. xxi, figs. 1–13; Iconogr., pl. xx, fig. 4.—Heer, Fl. Tert. Helv., ii, p. 40, pl. lxxi, figs. 19 *b*, *c*, *d*, *e*, lxxii, figs. 2–34, lxxiii, figs. 2–4; Fl. Foss. Arct., p. 103, pl. xlix, fig. 9; Fl. Foss. Alask., p. 29, pl. ii, fig. 12, etc.—Lesqx., Annual Report, 1874, p. 313.

Leaves oblong-ovate or ovate-lanceolate, taper-pointed, doubly serrate; secondary nerves close, parallel, straight to the borders, simple or scarcely branching.

The leaves vary in size, from three to ten centimeters long and from two to five centimeters broad; their nervation is sharply marked, for the secondary veins at least, which, nearly always simple, parallel, close, pass straight to the borders in a more or less acute angle of divergence, according to the width of the leaves. These are mostly oblong and taper-pointed or acuminate; their base is generally round, or subtruncate. In fig. 9 of plate lxiv, the base appears cuneate; but the leaf seems to have been lacerated on both sides. This, however, if even the base of the leaf was wedge-shaped, could not separate it from the species, as some of the leaves figured by the authors are more or less acutely cuneate to the base. The nervilles are extremely thin and scarcely perceivable upon our specimens; fig. 9 of pl. xix has the lateral veins more distant, and the substance of the leaf is apparently of a thicker consistence, membranaceous or subcoriaceous. For this reason I considered this leaf at first as a *Quercus*, under the name of *Q. Elkoana* (Annual Report, 1873, p. 413). Heer, however (*loc. cit.*), has in fig. 24 a leaf with the veins nearly as distant; and the doubly serrate borders, with simple secondary veins, more evidently relate this fine fragment to this species, especially comparable to fig. 2 *b*, pl. lxxiii, of Heer, Fl. Tert. Helv.

HABITAT.—Near Florissant, Colorado (*Dr. F. V. Hayden*). Elko Station, Nevada (*Prof. E. D. Cope*).

CORYLUS, Tourn.

This genus at our time is represented in the northern hemisphere only. Of the seven species by which it is now known, two inhabit eastern Asia; three are found in Europe, none being confined to that continent, however, for two extend to Asia and one to Algeria. Two belong exclusively to North America: *Corylus Americana*, whose range of distribution is from Florida to Saskatshawan, and *C. rostrata*, which does not go southward far beyond the Alleghany Mountains, and ascends only to the great lakes. In the fossil flora, three species only are known by their leaves in the Miocene of Europe. One of them is nearly exclusively Arctic, its remains being found in great abundance in the Miocene of Greenland. It is, however, quite as common in the same formation of Alaska, and appears more rarely in the Miocene of the Rocky Mountains. The specimens figured as marked below are from Carbon and the Washakie group; some fragments, in a bad state of preservation, and therefore somewhat uncertain, have been found at Evanston. Four species of *Corylus* are described from the Union group by Dr. Newberry. From the similarity of the leaves of *C. Mac Quarrii* with those of our present species, it appears certain that these had their origin in geological times as far up as the Miocene at least, and also that their present characters and their distribution agree with those of their ancestors.

Corylus Mac Quarrii, (Forbes) Heer.

Plate XVIII, Figs. 9-11.

Alnites? Mac Quarrii, Forbes, Quart. Journ. Geol. Soc., 1851, p. 103.
Corylus Mac Quarrii, Heer, Fl. Arct., p. 104, pl. viii, figs. 9-12, ix, figs. 1-8, xvii, fig. 5 *d*, xix, fig. 7 *c*, p. 138, pl. xxi, fig. 11 *c*, xxii, figs. 1-6, xxiii, fig. 1, p. 149, pl. xxvi, figs. 1 *a*, 2-4, xxi, fig. 5; Fl. Foss. Alask., p. 29, pl. iii, fig. 9, pl. iv; Foss. Fl. of N. Greenl., p. 469, pl. xliv, fig. 11 *a*, xlv, fig. 6 *b*; Spitzb. Fl., p. 56, pl. xi, figs. 10-13, xiii, fig. 35 *b*.—Lesqx., Annual Report, 1871, p. 292; Supplement, p. 9.
Alnus pseudoglutinosa, Goepp., Tert. Fl. d. Polar Geg., 1861.
Corylus grosse-serrata, Heer, Fl. Tert. Helv., ii, p. 44, pl. lxxiii, figs. 18, 19.

Leaves of medium size, very variable, oblong or oval, pointed or acuminate, rounded, truncate or emarginate at the base, triply serrate, penninerved; lateral veins thick, branching, craspedodrome, like their divisions.

The immense number of specimens, some of them in a perfect state of preservation, which have been examined by Prof. Heer, have enabled him to compare the various forms of these leaves, and to refer them to the same species. Seen separately in two or three fragmentary specimens, like those figured here, it is difficult to find their points of identity, and therefore easy to refer each leaf to a different species. The surface of these *Corylus* leaves is

always rough; the secondary veins and their divisions are traced deep into the derm, and the nervilles are also deep and distinct, though the details of areolation are rarely so. It is always difficult, in our specimens at least, to recognize the triple denticulation of the borders, the teeth sometimes appearing simple, and being generally more or less destroyed or erased.

HABITAT.—Carbon Station, Wyoming; Washakie group (*Dr. F. V. Hayden*). I have not seen as yet any specimens of the species from the Upper Miocene of Green River and the Parks. Those from the Lower Lignitic are indistinct and scarcely determinable.

FAGUS, Tournf.

One of the more clearly defined generic types of the Cretaceous Dakota group flora is that of *Fagus*. Two species, described from leaves (they may, however, represent one only), have been published from this formation, *Fagus polyclada* (Lesqx., Report of the U. S. Geol. Surveys of the Territories, vol. vi, p. 67, pl. v, fig. 6) and *F. cretacea* (Newby., Notes on the Later Extinct Floras of N. A., p. 23). From this it seems that a genus whose origin is recognized in the Cretaceous, and which, by the wide distribution of one of its species at the present time through the eastern slope of the North American continent, furnishes one of the principal constituents of its forests, should have left its traces through the intermediate geological formation by an abundance of its fossil remains. As yet, it is not the case. No positively determinable fossil leaves referable to *Fagus* have been observed in the Lower Lignitic of the Rocky Mountains, and none either in the higher stage of the Eocene at Evanston or in the Miocene of Carbon. The species described here below as *Fagus Feroniæ* is from the Upper Tertiary (Miocene) of the Rocky Mountains, and even, as it may be seen from the remarks in the description, it is not certain that the leaves referred to it truly belong to this genus. We have to go higher still in the Tertiary formations, or in the Pliocene of the Chalk Bluffs of California, to find vegetable remains as distinctly identifiable with Beech as are those of the Cretaceous. This may seem a strange inconsistency of distribution. It may be accounted for, as in other analogous cases, by our insufficient acquaintance with the geological floras of this continent, represented as they still are by comparatively scanty materials. The proof is, that fruits of *Fagus*, perfectly similar to those of the living species, have been found in the Lower Lignitic of Tennessee and

Mississippi, and described as *Fagus ferruginea*, in the Geological Report of Tennessee, 1869, p. 427, pl. K, fig. 11. Prof. Heer also identifies two species of *Fagus* in the Miocene of Alaska, whose synchronism with the Lignitic deposits of Carbon is evinced by a number of identical specific types. One of those Alaska species, *Fagus Antipofi*, is in the Chalk Bluffs formation of California, and another, *F. castaneæfolia*, Heer, is recognized in the Miocene of Oregon. Therefore the persistence of the generic type in the subsequent stages of the North American Tertiary seems sufficiently established.

Besides the two uncertain species of the Eocene of France, European paleontologists have recognized ten fossil species of Beech, mostly Miocene; two of them ranging from Greenland to Italy and Syria. All except one are intimately allied to the living species of North Europe and North America, *Fagus ferruginea*, Ait., and *Fagus sylvatica*, Linn., to which may be added the Japanese *F. Sieboldi*, Endl., or to the northern types. The other living species, twelve in number, all inhabit the austral hemisphere, and to one of these, *F. obliqua*, Mirb., of Chili, one Miocene species only, *F. pygmæa*, Ung., from Eubæa, is comparable.

Fagus Feroniæ, Ung.

Plate XIX, Figs. 1–3.

Fagus Feroniæ, Ung., Chlor. Protog., p. 106, pl. xxviii, figs. 3, 4.—Ett., Beitr. z. Foss. Fl. v. Tokay (Sitz.-Ber. d. K. K. Ak. d. Wiss.), xi, p. 799; Foss. Fl. v. Bil., i, p. 50, pl. xxv, figs. 12–20.—Lesqx., Annual Report, 1873, p. 413.

Fagus Deucalionis, Ung., Iconogr., p. 38, pl. xviii, fig. 24.

Ulmus quercifolia, Ung., Chlor. Protog., p. 96, pl. xxv, fig. 5.

Quercus myricæfolia, Ung., Iconogr., p. 37, pl. xviii.

Leaves ovate or oblong, pointed or acuminate, narrowed or broadly wedge-form to a comparatively long petiole; borders irregularly dentate; secondary veins simple, parallel, craspedodrome, scarcely curved in passing to the borders.

The three leaves referred here to this species agree so exactly in all their characters with those published by the European authors, as seen above, and also with the description in Schimper (Pal. Végét., ii, p. 603), that it is scarcely possible to doubt their identity. Their size is variable; their ovate-acuminate form, their irregular dentation, the comparatively long petiole, the distribution, and also the degree of divergence of the secondary veins, are the same. The American forms appear only slightly more acutely narrowed to the petiole, but a difference of the same kind is remarked between the leaves figured by the authors, as between figs. 3 and 4 of pl. xxviii of Ung. Chlor. Protog., and therefore cannot be considered as specific. It is, however, questionable if all these leaves may be referred to *Fagus*. This

uncertainty is evident from Unger's synonymy, and is still more forcibly suggested by the fact that no species of *Fagus* has leaves with doubly dentate borders. This is a question, however, which has to be decided by European authors.

HABITAT.—Elko, Nevada (*Prof. E. D. Cope*). The two specimens from Golden described under this specific name in Annual Report, 1872, p. 378, are mere fragments, too imperfect for satisfactory determination. The same remark is applicable to the single leaf referred to *Fagus Deucalionis*, Ung., from Evanston specimens, in Annual Report, 1871, p. 292.

QUERCUS, Linn.

The distribution of the Oaks at the present time affords some interesting data, which may be considered with reference to what is known of the development of the genus in the geological times.

Of the two hundred and eighty species described in the Prodromus, the North American continent has for its share one hundred and twenty-one, thirty of which belong to the United States, including New Mexico, and eighty-five to Mexico, most of them, at least; for a few species descend farther south to Costa Rica, even to New Granada, one of these being found in the mountains near Bogota, 5° north of the equator. Of the twenty-five species which are credited to Europe, nine are Mediterranean, passing to North Africa and to Western Asia. None but these Mediterranean species have been found upon the continent of Africa. From Asia, one hundred and twenty species are described, a large number from the southern peninsula and from the depending islands, Java and Sumatra; even a few from the Philippines and Celebes Islands. In that continent, the genus extends its representatives to 5° south of the equator. Japan is credited with nineteen species. From this we see that the Oaks belong to the northern hemisphere nearly exclusively, as very few species pass below the equator in Asia, and as South America, Australia, and Africa (except those of the southern shores of the Mediterranean) have none. This fact is worth remarking, as the range of habitat of the Oaks is as variable as the characters of their leaves; and therefore they should have, more than any other genera, by their facility of adaptation to every kind of climatic circumstance, a world-wide, or at least a more general, distribution. Considering the species of the eastern slope of the United States, Gray's Statistics of the Flora gives to *Quercus palustris* a

range of 6° only, while *Q. rubra*, *Q. alba*, and *Q. obtusiloba* have their place in the list of the species ranging from nineteen to twenty-nine degrees of latitude.

The disposition of Oaks to constitute varieties by hybridity is well known. This has rendered the specification of many of their forms very difficult and uncertain. It is therefore not surprising to find the same uncertainty in regard to a number of the fossil forms referred to this genus, and which are identifiable by leaves only, the most variable and diversified organism of all.

Considering what is known of Oaks in geological times, species of *Quercus* are positively and distinctly represented in the Cretaceous; at least, if we admit as representatives of this genus the leaves of the Cretaceous of Belgium, which have been separated by Debey and d'Ettingshausen, under the generic name of *Dryophyllum*, for reasons which have not been as yet satisfactorily explained. These leaves have the same characters as certain species of Oaks; and, compared for their nervation, their form, even their consistence to those of some of the North American living species, they do not present any mentionable difference. The fine leaf, for example, described in the Supplement to the Cretaceous Flora, Annual Report, 1874, as *Dryophyllum* (*Quercus*) *latifolium*, p. 340, pl. vi, fig. 1, is like a counterpart of some leaves of *Quercus bicolor;* and that of *Quercus primordialis* of the Cretaceous Flora (Rep. U. S. Geol. Surv. of the Terr., vol. vi, p. 64, pl. v, fig. 7) is equally similar to leaves of *Q. prinos.* The section of the Willow-oaks, the *Salicifoliæ*, established by Schimper for species with entire leaves, is less definitively recognized in the Cretaceous. The characters of *Quercus salicifolia* and *Q. cuneata*, Newby., like those of *Q. Ellsworthiana*, Lesqx., do not exclusively pertain to Oaks; therefore the relation of the leaves representing these forms is somewhat doubtful. However, the evidence afforded to this question by geological records seems to prove the origin of at least two different types of Oaks in the Cretaceous; for the Paleocene of France has five species, described by Watelet, and, besides those which are mentioned here below, five others have been recently observed by Saporta in the Gelinden formation, which, considered for a long time as Upper Cretaceous, is now definitively recognized as the lowest member of the Eocene of that country. Three of these Oaks, according to the author's remarks, go to the section *Lepidobalanus*, the two others represent that of *Cerris.* Higher into the Tertiary, the

European authors describe a few species from the Middle Eocene, and still a larger number from the upper measures, the Oligocene or Armissan. It is, however, in the Miocene that the genus reaches its full development; and, judging from data obtained from the study of the North American Tertiary floras, the predominance of Oaks increases even into the Upper Miocene and the Pliocene, for, in fifty species which represent the flora of the Chalk Bluffs of California, nine, or more than seventeen per cent., belong to *Quercus*. This proportion, as far as it can be estimated, is far above that of the Oaks in the present North American flora; for, counting the arborescent, or woody hard species, which could be preserved by fossilization, in supposing analogous circumstances, the Oaks of the eastern slope of the United States would not constitute more than six per cent. of its flora.

Prof. W. P. Schimper, in his Paléontologie Végétale, describes one hundred and sixty fossil species of Oaks, which he distributes in five different sections:—

In the first, that of the *Salicifoliæ*, he has forty-seven species, four of which are Cretaceous, twelve Eocene, and thirty-one Miocene. Among the Eocene species, he places three described from Vancouver's Island.

In the second section, which includes the species with serrate or dentate leaves, he has thirty-nine species, three of which are Cretaceous and five Eocene; of these, three are North American. This disproportion in the distribution is rather uncertain, however, and explainable in part by the fact that the Eocene floras of Europe, that of Mount Bolca, for example, are still unknown, and also by the reason that some species referable to this section are described by Schimper under the generic name of *Dryophyllum*. Of these, the Sézanne flora (Lower Eocene) has four; that of Gelinden, a still lower formation, has five (these published since the Paléontologie Végétale was out); and two more have been more recently discovered in the Point of Rocks measures of Wyoming, which, by its flora, characterizes the lowest Tertiary of this country.

Schimper's third section has the species with coriaceous, few-nerved, or indistinctly nerved leaves, which are generally of difficult and uncertain determination. It contains thirty species, three Oligocene, one Quaternary, the other Miocene. *Quercus acutiloba*, a well-characterized Oligocene species of this section, has been found also at Golden in the Lower Lignitic of Colorado.

The fourth section, for lobato-crenate leaves and craspedodrome secondary veins, has only four species, which, I think, should be placed in the second division; for *Quercus castanea* and *Q. furcinervis* are evidently derivations of *Dryophyllum*, or referable to the same section; while *Q. elymodrys* and *Q. Deuterogena*, two species of Unger, are comparable to *Q. prinoides* and *Q. montana*, a type of the North American flora, which, as seen above, appears also derived from *Dryophyllum*.

To the fifth section pertain the species with sinuate-lobed borders, like those of our White Oaks. It has only twelve species, all Miocene, especially Upper Miocene. As yet, this type is recognized in the Tertiary flora of this continent by one species only from the Pliocene of California. However, *Q. Furuhjelmi*, Heer, from Alaska, is placed by Schimper in this section, and as this species is closely allied on one side to the Cretaceous *Dryophyllum* (*Quercus*) *latifolium*, on the other to the present *Q. bicolor*, we may, without a too hazardous hypothesis, consider this group as identical with the former, the leaves passing, by the deepening of the obtuse teeth into lobes, to *Q. alba*, *Q. macrocarpa*, etc., and, by narrowing them into more acute teeth, to *Q. prinos*, or to the fossil species *Q. pseudo-castanea*, *Q. furcinervis*, etc.

The last section of Schimper is reserved for the doubtful species, twenty-four in number, two of them known only by fruits.

From this it may be assumed that the different groups of Oaks of the North American present flora, at least those of the eastern slope, have their origin recorded in the Cretaceous by some related specific types; that the original characters, those pertaining to the fourth section, are recognized in species of the Eocene of the Rocky Mountains; and that perhaps even the genus takes its preponderance in North America, as in Europe, during the Miocene period, especially in this country in the Pliocene.

§ I.—*Leaves with entire borders.*

Quercus neriifolia, Al. Br.

Plate XIX, Figs. 4, 5.

Quercus neriifolia, Heer, Fl. Tert. Helv., ii, p. 45, pl. lxxiv, figs. 1–6, 16 *a*, *b*, *c*, *d* (acorns), pl. lxxv, fig. 2; iii, p. 178, pl. clii, fig. 3.—Ung., Gen. et Sp., p. 403.—Ett., Foss. Fl. v. Bil., p. 54.—Gaud., Cont., vi, p. 12, pl. ii, fig. 1.—Lesqx., Annual Report, 1873, p. 413.
Quercus lignitum, Al. Br., Stizenb. Verz., p. 77.—Heer, Ueber der Tert. Fl., p. 53.
Quercus commutata, Heer, Fl. Tert. Helv., pp. 14, 21.

Leaves coriaceous, with polished surface, narrowly lanceolate, gradually tapering toward the base; middle nerve thick and deep; secondary veins on a very open angle of divergence, sparingly branching toward the borders, where they are effaced; generally separated by shorter intermediate tertiary veins.

The two specimens referred to this species are very imperfect. One (fig. 5), with coriaceous texture, smooth surface, gradually narrowed downward, has, however, the characters of this species, especially as marked by Heer (*loc. cit.*, figs. 3, 4). The secondary veins are close, open, on an angle of divergence of 60°, with shorter intermediate tertiary veins. The fragment represented in fig. 4 is less distinctly identified with this species by the coriaceous substance of the leaf, its open veins nearly at right angle to the thick midrib, toward the base, and more evidently branching near the border.

HABITAT.—Near Florissant, west of Pike's Peak, Colorado (*Dr. A. C. Peale*), specimen represented in fig. 4. Raton Mountains, New Mexico (*Dr. F. V. Hayden*), specimen represented in fig. 5.

Quercus straminea, Lesqx.

Plate XIX, Figs. 6, 7.

Quercus straminea, Lesqx., Annual Report, 1872, p. 373.

Leaves variable in size, broadly ovate, obtusely pointed, rounded downward, or narrowed to a short petiole; secondary veins parallel, on an open angle of divergence, camptodrome.

These leaves seem to represent two different species. They have, however, a common character, that of the yellowish, shining, secondary veins, which I have not seen on any other species of fossil plants of this locality. The leaf in fig. 6 is smaller, with the secondary veins at a more acute angle of divergence; it has, however, the same character of nervation, shorter intermediate tertiary veins, and more or less distinct veinlets, oblique to the secondary veins. In both leaves, also, the basilar veins are marginal, and ascend to the branches of the secondary nerves above. This species is distantly related by its nervation to *Quercus Desloësi*, Heer (Fl. Tert. Helv.), as represented in pl. lxxviii, fig. 7, a species which shows in different fragments (figs. 6 and 14) a marked diversity in the size of the leaves and in the angle of divergence of the secondary veins.

HABITAT.—Golden, Colorado.

Quercus chlorophylla, Ung.

Plate XXI, Fig. 3.

Quercus chlorophylla, Ung., Chlor. Protog., p. 111, pl. xxxi, fig. 1.—Heer, Fl. Tert. Helv., ii, p. 47, pl. lxxv, figs. 3-9.—Massal., Fl. Foss. Senog., pl. xxx, fig. 4.—Sism., Mater., p. 41, pl. ix, fig. 5.—Lesqx., Trans. Amer. Phil. Soc., xiii, p. 416, pl. xvii, figs. 5-7; Annual Report, 1869, p. 196; Supplement to Annual Report, 1871, p. 14; Annual Report, 1872, pp. 383, 407.

Leaves coriaceous, ovate, obtuse, rounded in narrowing to a short petiole; borders entire, undulate, apparently recurved; secondary veins thin, obsolete, camptodrome.

Though a number of fragments referable to this species have been found, none represent a full leaf, and the more complete specimen is here figured.

Generally the leaves are more distinctly narrowed to the short petiole than in this one; but even in the European specimens, as for example in the fine branch figured by Sismonda (*loc. cit.*), this character is remarked quite as frequently as that of the more acutely cuneate base. The differences are especially appreciable in the three leaves from the Mississippi Lower Lignitic, in Trans. Amer. Phil. Soc., *loc. cit.*, where fig. 5 has its base still more obtusely rounded than in the leaf figured here; while fig. 7 has its lower part more narrowed, as it is in the leaves described by Heer, and fig. 6 is intermediate between both. In all the fragments which have come under my examination, the substance of the leaves appears coriaceous; the secondary veins are scarcely perceivable and the borders seem narrowly reflexed. The leaves do not vary greatly in size, averaging eight centimeters long and three to four centimeters broad, being always, as seen in the figures given by the authors cited, either obtuse or rounded, or even slightly emarginate at the point.

HABITAT.—Marshall's, Erie, Colorado. Fischer Peak of the Raton Mountains, New Mexico (*Dr. F. V. Hayden*). Six miles above Spring Cañon, near Fort Ellis, Montana (*Dr. A. C. Peale*). The specimen from this last locality is obscure.

Quercus cinereoides, sp. nov.

Plate XXI, Fig. 6.

Leaf small, subcoriaceous, entire, narrowly ovate-lanceolate, acuminate, rounded to the petiole; middle nerve narrow; secondary veins curving toward the borders, camptodrome.

This fine leaf, nearly five centimeters long, two centimeters broad in the middle, its widest part, is narrowed by a curve to the base, and seems to be short-petioled (petiole broken). The secondary veins at unequal distance, but parallel, join the narrow middle nerve under an angle of divergence of 40°, first nearly straight, then curving near and along the borders, or camptodrome; the areas are all primary ones and undivided except by nervilles, which, at right angle to the middle and secondary nerves, branch nearly in the same direction, and form irregularly square or rectangular areolæ. The relation of this species is marked with the North American *Quercus cinerea*, Michx., of the pine-barrens of the South, or to *Quercus phellos*, var. *maritima*, for its nervation at least. Among the fossil species, it is especially comparable to *Quercus salicina*, Sap. (Ét., i, p. 24, pl. vi, fig. 6), of the Gypses of Aix, France.

HABITAT.—Locality unknown.

§ II.—*Leaves serrate, dentate, or crenate.*

Quercus Valdensis, Heer.

Plate XIX, Fig. 8.

Quercus Valdensis, Heer, Fl. Tert. Helv., ii, p. 49, pl. lxxviii, fig. 15; iii, p. 178, pl. cli, fig. 17.—Ett., Foss. Fl. v. Bil., p. 56, pl. xvi, figs. 5, 6, 7.

Leaves coriaceous, ovate, acuminate, rounded to the petiole; secondary veins close, parallel, more open toward the base, subcamptodrome; borders obscurely dentate.

This fragment, representing the lower part of a coriaceous leaf, whose base is rounded to a slender, short petiole, has rather the appearance of a leaf of *Betula*, or of *Ostrya*, than of a *Quercus*. It resembles closely, however, the fragment described by Heer (*loc. cit.*, fig. 15) by its coriaceous consistence, its form, and nervation. The sharp denticulation of the teeth is not distinct in this specimen. I have seen another, from Contra Costa, California, which is more perfect, representing a whole leaf, acuminate and sharply dentate, with the same type of nervation as this one, and evidently referable to the same species. The secondary veins are subcamptodrome, either following along the borders in festoons and entering the teeth by nervilles, or some of them passing up to the point of the teeth, as marked by d'Ettingshausen (*loc. cit.*, fig. 7). This species is evidently extremely variable; for the leaves seen by this last author are obtuse, some of them round-oval; in all, however, the secondary veins are more open toward the base, and the nervilles distinct, nearly simple, and continuous in right angle to the veins.

HABITAT.—Lignites of Rock Creek, Laramie Plains, Wyoming, with *Quercus acrodon*, *Populus subrotundata*, etc. (*Dr. F. V. Hayden*).

Quercus Godeti?, Heer.

Plate XX, Fig. 1.

Quercus Godeti, Heer, Fl. Tert. Helv., ii, p. 50, pl. lxxviii, figs. 10, 11; iii, p. 179, pl. cli, fig. 11.—Lesqx., Annual Report, 1871, p. 297.

Leaf subcoriaceous, lanceolate, tapering upward, rounded to the base; borders serrato-dentate; secondary nerves numerous, parallel, branching near the borders, camptodrome, separated by tertiary shorter veins.

Of the two specimens which we have of this species, the best preserved one is figured here. The leaves appear coriaceous, or, at least, subcoriaceous, their surface being blackened by an adhering thin coating of coaly matter and undulately wrinkled across, as in coriaceous leaves; the stone is, however, too coarse to show the thickness of the vegetable remains imbedded into it. These leaves are unequal at the base, more enlarged and rounded on one

side, and tapering to a point (?) (broken). The only difference remarked between this leaf and the one figured by Heer (*loc. cit.*, pl. li, fig. 11), is in the size of the teeth, which are shorter in the American form; they are, however, sharply pointed and unequal. The secondary veins are exactly of the same character as in Heer's species, branching toward the borders, camptodrome, with intermediate, short, tertiary veins, sometimes on a more open angle of divergence. These leaves, even if their identification with the Miocene species of Europe were positively ascertained, do not seem to be referable to Oaks. By their small, sharp teeth, their unequal base, their nervation also, they closely resemble the leaflets of some compound leaves, like those of some *Aralia*, our *A. spinosa* for example, which, however, are not thick.

HABITAT.—Six miles above Spring Cañon, Montana, with *Cinnamomum lanceolatum*, *Rhamnus rectinervis*, etc. (*Dr. F. V. Hayden*).

Quercus Cleburni, Lesqx.

Plate XX, Fig. 2.

Quercus Cleburni, Lesqx., Annual Report, 1873, p. 399.

Leaf coriaceous, linear-oblong, narrowed to the base, obtusely dentate; secondary veins short and obsolete, nearly at right angle to the midrib.

The upper part of the only leaf which represents this species being destroyed and the nervation obsolete, its characters are indefinite. Its peculiar form and nervation, however, and the flat, slightly obtuse teeth of the borders, even the unequilateral base, are characters identical with those of *Quercus urophylla*, Ung. (Fl. v. Sotzka, p. 33, pl. ix, fig. 9). As in our species, also, the lateral veins are in right angle to the midrib. From the numerous figures given of that *Quercus* by the German author, the leaves are seen to be extremely variable, especially in the characters of the denticulation of the borders and the direction of the secondary veins.

HABITAT.—Black Buttes, Wyoming.

Quercus? fraxinifolia, Lesqx.

Plate XX, Fig. 3.

Quercus Laharpi, Gaud.—Lesqx., Annual Report, 1871, p. 297.

Leaves membranaceous, lanceolate, rounded and narrowed to the entire base, tapering to the obtusely dentate point; secondary veins close, numerous, curving in passing up to the borders, camptodrome.

This leaf, known only from one specimen, is about eight centimeters long, two centimeters broad in its lower part, entire from the base to near the

middle, obtusely dentate above, with numerous parallel, camptodrome, secondary veins, diverging about 40°, slightly more open in the lower part of the leaf. The reference to *Quercus Laharpi* is contradicted by the total absence of nervilles, the more numerous, closer, secondary veins, and the curve of the borders of the leaf to the base, or to the petiole. It resembles some species of *Fraxinus*, like *F. denticulata*, Heer (Mioc. Balt. Fl., p. 89, pl. xxiv, figs. 26 and 27). The absence of the details of nervation prevents a satisfactory comparison and identification of this leaf.

HABITAT.—Six miles above Spring Cañon, Montana (*Dr. F. V. Hayden*).

Quercus Ellisiana, Lesqx.

Plate XX, Figs. 4, 5, 7, 8.

Quercus Ellisiana, Lesqx., Annual Report, 1871, p. 297.

Leaves broadly ovate or ovate-lanceolate, obtusely pointed, obtusely dentate in the upper part, broadly cuneate to a short petiole; secondary veins at an open angle of divergence, slightly curving in passing to the borders and entering the teeth.

All the leaves of this locality are upon coarse metamorphic sandstone, which the vegetable substance seems to have penetrated, and upon which the outlines and the essential parts of the nervation are preserved as painted in black. For this reason, the original consistence of the leaves is inappreciable. These leaves are numerous, variable in shape, broadly rhomboidal, and entire, or with undulate borders, as in fig. 7; or ovate and broadly wedge-form toward the point and the base, and distinctly obtusely dentate in the upper part, as in fig. 4; or oval, undulate, or dentate above, as in figs 5 and 8. The nervation is variable in the same degree, the secondary veins being either forking, distant, open (angle of divergence 40° to 50°), as in figs. 4 and 7, or more numerous, closer, simple, and more oblique, as in fig. 5. A number of fragmentary specimens unite all these forms in one species by transition between their characters. Their general outline is that of leaves of *Alnus*, a genus to which they might be referable; but the narrow lanceolate leaves, like that of fig. 5, rather resemble *Quercus* leaves, at least some of those described as *Quercus* by European authors. Thus this species is closely allied to *Quercus pseudo-alnus*, Ett. (Foss. Fl. v. Bil., p. 59, pl. xvii, figs. 3–6), merely differing by the character of the denticulation, which is generally more obtuse in the American form, and does not descend so far down.

HABITAT.—Six miles above Spring Cañon, near Fort Ellis, Montana (*Dr. F. V. Hayden*).

Quercus Pealei, Lesqx.

Plate XX, Fig. 6.

Quercus Pealei, Lesqx., Annual Report, 1871, p. 297; 1872, p. 406.

Leaf coriaceous, small, cuneate, and entire from the middle to the base (petiole broken), more abruptly narrowed to an obtuse point, and undulato-dentate in the upper part; lower pair of secondary veins from the base of the leaf, opposite, at a more acute angle of divergence, and camptodrome; upper pair alternate, distant, sparingly branching, craspedodrome.

This small leaf, four centimeters long and two centimeters broad in the middle, may be referable to the former species. The character of the nervation appears at first very different; but, comparing fig. 4 to fig. 6 of the same plate, the analogy in the position and direction of the secondary veins becomes more evident, for in fig. 6, as indicated by the festoons of the tertiary veins or branches along the borders above the broken part, the leaf has, like that of fig. 4, a marginal vein, whose place is taken on the other side by a camptodrome secondary vein. The more marked difference which induced me to separate this species is the more evidently coriaceous substance of this leaf and the discernible nervilles. It appears intimately related to *Quercus fagifolia* and *Q. triangularis*, Goepp. (Schoss. Tert. Fl., pp. 14 and 15, pl. vi, figs. 9–17),—two species described by Schimper as *Parrotia fagifolia*.

HABITAT.—Six miles above Spring Cañon, Montana (*Dr. A. C. Peale*). Near Fort Ellis, Montana (*Jos. Savage*).

Quercus Haidingeri, Ett

Plate XX, Figs. 9, 10.

Quercus Haidingeri, Ett., Foss. Fl. v. Vien., p. 12, pl. ii, fig. 1.—Heer, Fl. Tert. Helv., ii, p. 53, pl. lxxvi, figs. 5, 7, 8, 10, 14.—Gaud., Contr., ii, p. 42, pl. iii, fig. 6.—Lesqx., Annual Report, 1874, p. 313.

Leaves subcoriaceous, broadly lanceolate, acuminate, narrowed to the base; borders crenulato-serrate; lateral nerves unequidistant, sparingly branching, effaced toward the borders, camptodrome.

The American leaves representing this species are slightly larger than those of the European Tertiary, especially that of our fig. 10. They agree, however, so well by all their characters with those described under this name, that I consider the identity as undeniable. The size is from ten to fourteen centimeters long, and three and a half to five centimeters broad below the middle. The largest leaf in Heer (*loc. cit.*, fig. 4) is as long as that of our fig. 9, and slightly narrower. The narrowly ovate-oblong shape of the leaves, tapering upward to an acumen and slightly more rapidly narrowed in curving to the base, the crenulate or dentate borders, are the same, and the inequidistant secondary nerves, some of them simple, some sparingly branching,

with tertiary intermediate veins, are also of the same character as seen in Heer (*loc. cit.*, figs. 7 and 14). This species is related by some of its characters to the two former ones. As Heer and d'Ettingshausen, also, have found and described the fruits of this species, its relation to this genus seems sufficiently established.

HABITAT.—Green River, Wyoming, with *Ficus arenacea*, *F. Gaudini*, *Populus arctica*, etc., described hereafter (*Dr. F. V. Hayden*).

Quercus drymeja, Ung.

Plate XIX, Fig. 14.

Quercus drymeja, Ung., Chlor. Protog., p. 113, pl. xxxii, figs. 1–4.—Heer, Fl. Tert. Helv., ii, p. 50, pl. lxxv, figs. 18, 19, 20.—Ung., Foss. Fl. v. Sotzka, p. 33, pl. ix, figs. 1, 2.—Gaud., Contr., i, p. 17, pl. vi, fig. 4; vii, fig. 4; ii, p. 44, pl. iv, figs. 1–10.—Ett., Foss. Fl. v. Bil., i, p. 58, pl. xvi, fig. 9.—Massal., Stud., p. 186, pl. xxiv, fig. 7.—Sism., Mater., p. 46, pl. xvii, fig. 1, etc.

Leaf linear, apparently acuminate; borders equally distantly dentate; lateral veins in an acute angle of divergence, nearly straight to the borders, craspedodrome.

There is perhaps no sufficient evidence of the reference to this species of the fragment figured here. It has the form and size of the leaf of Unger's Fl. v. Sotzka (*loc. cit.*), fig. 2; the nervation is of the same character, the secondary veins passing up in an acute angle of divergence and nearly straight to the point of the teeth, and also the subfalcate shape of the linear-lanceolate leaf is similar. In fig. 9 of the Bil. Fl. (*loc. cit.*), the linear leaf, the angle of divergence, 30°, of the veins, and the distant teeth, are of the same character also; and, indeed, I do not know any other species, either fossil or living, to which this fragment might be more legitimately referred. The difference in the form of the teeth, either very acute or somewhat obtuse, is remarked also upon the fragment, as well as upon the leaves figured by European authors.

HABITAT.—Near Castello's Ranch, Colorado (*Dr. F. V. Hayden*).

Quercus Haydenii, Lesqx.

Plate XIX, Fig. 10.

Quercus Haydenii, Lesqx., Annual Report, 1869, p. 196.

Leaf lyrate, sharply dentate toward the enlarged base and at the abruptly narrowed point; nervation palmato-pinnate; lower lateral veins branching, open, the upper one distant, parallel, all craspedodrome.

This leaf has no relation to any fossil ones known to me. Its general outline is somewhat like that of the leaves of *Liriodendron*. Enlarged at the nearly truncate base, and there round-lobed, with dentate borders, it is narrowed or strangled in the middle, and still enlarged upward, with its top broadly deltoid and sharply dentate. The middle part of the leaf only has entire

borders. The nervation is as irregular as the form, being tripalmate at the base, with the lateral veins, one only and branching on one side, while on the other they are double and parallel, with three pairs of secondary veins above, at a distance from the primary nerves; a nervation related to that of *Platanus.* Indeed, by its sharp teeth, turned upward, this peculiar leaf might be taken for a deformity of the common *P. aceroides* or *P. Guillelmæ*, but for its remarkable shape. As it comes from the same locality as the specimens of the following and apparently very variable species, it may belong to it. This possible relation indicates its place in this genus. It seems to represent a transitional form between the dentate and the lobate leaves of *Quercus.*

HABITAT.—Laramie Plains, near Rock Creek, Wyoming (*Dr. F. V. Hayden*).

Quercus acrodon, Lesqx.

Plate XIX, Figs. 11–13.

Quercus acrodon, Lesqx., Annual Report, 1869, p. 196; 1872, p. 389.

Leaves oval or obovate, more or less rapidly narrowed upward to an acute point and downward to the petiole; borders sharply deeply dentate; lateral nerves parallel, equidistant, craspedodrome.

The three fragments figured here expose the general characters of the leaves of this fine species. The form is ovate, either narrowed in about the same degree to an acute point and to the petiole (broken), as in fig. 12, or obovate, rounded upward to a short point, and narrowed cuneiform to the base. The borders are sharply dentate, sometimes with unequal teeth, as in fig. 13, but the teeth are all turning upward and deep, separated by obtuse sinuses. The secondary nerves, mostly simple, some of them, however, branching near the borders, pass up, all in the same angle of divergence, 40°, either straight or slightly curving, entering the teeth as well as their branches. The substance of these leaves is not coriaceous, the areolation being, however, rendered obsolete by a thin coating of carbonaceous matter. In fig. 11, only the netting is distinctly seen, formed by veinlets in right angle to the nerves, close, dividing, either obliquely or in right angle, into quadrangular meshes. The base of the leaves only has entire borders.

Like the former leaf, these have no direct relation to those of any fossil species of *Quercus* published by authors. Among living species, its affinity is with *Q. agrifolia*, Nee., of California.

HABITAT.—Same locality as the former (*Dr. F. V. Hayden*).

Quercus Viburnifolia, Lesqx.

Plate XX, Figs. 11, 12.

Quercus attenuata?, Goepp., Lesqx., Annual Report, 1873, p. 398
Quercus triangularis, Goepp., Lesqx. (in part), Annual Report, 1872, p. 377.

Leaves oval-oblong, narrowed and broadly cuneate downward to a slender petiole and upward to a short point; borders distantly dentate; nervation pinnate, craspedodrome.

Except for the character of denticulation of the borders, the leaf in fig. 11 is quite as similar to *Q. attenuata*, Goepp. (Tert. Fl. v. Schoss., pl. viii, fig. 4), as that of fig. 12 is to *Q. triangularis* of the same work (pl. vi, figs. 13–17). The first of these leaves of ours differs by the distant, short teeth of the borders, turned upward and mostly simple, while Göppert's leaves are doubly dentate, with very small teeth turned outside. The second leaf (fig. 12) has, as seen in the upper part of the left side, small, simple teeth, agreeing in characters with those of fig. 11, while Göppert's *Q. triangularis* has undulate borders. In all these leaves, the general outlines and the nervation are the same, and they evidently refer to the same genus. But, considering its slender, apparently long petiole, the relation of these leaves to the species of the German author, or even to *Quercus*, seems uncertain. Count Saporta considers them as rather representing a *Viburnum*. Indeed, they have some affinity to *V. marginatum* of pl. xxxviii, figs. 1–5, of this volume, their relation, especially with fig. 2, being more appreciable. As in the species from Black Buttes, that of Golden shows a cuneate base, lower secondary veins opposite, emerging a little above the border base of the leaves, branching outside, all the nerves and primary branches entering the short teeth, and a broadly angular top, as wide as in *V. marginatum*, at least as it is in the leaves of figs. 2 and 3 (*loc. cit.*). There is a great difference, however, in the thin, more distant, secondary veins of this species, and in the general outlines of the leaves. These vary in size from four to nine centimeters long and from three and a half to six centimeters broad in the middle, where they are widest, their shape being rhomboidal; the petiole of the largest leaf is one and a half centimeters long to the point where it is broken; the angle of divergence of the veins, 40°, is the same in both leaves, as is also the number of the secondary veins in comparison to the size, the smaller leaf having four pairs only, and the large five, all slightly curving in passing up to the borders.

HABITAT.—Sand Creek, Colorado (*A. R. Marvine*), Golden, Colorado, and Black Buttes, Wyoming. The specimens from Black Buttes are upon burned red, very hard clay-shale, where the vegetable organs have been somewhat obliterated by heat. They are, however, identifiable.

Quercus platania, Heer.

Plate XXI, Fig. 1.

Quercus platania, Heer, Fl. Foss. Arct., i, p. 109, pl. xi, fig. 6, xlvi, fig. 7; ii, pl. xlvi, fig. 5, lv, fig. 3*c*; Spitz. Fl., p. 57, pl. xii, figs. 5–7.—Lesqx., Annual Report, 1872, p. 386.

Leaves membranaceous, very large, round-cordate to the base; borders simply dentate; secondary veins thick, the basilar ones opposite, more distant from the upper pairs, and branching, all slightly curving inside in ascending to the borders, craspedodrome.

This fine leaf indicates, by the preserved fragment, its lower part, a width of thirteen centimeters and a length of about twenty centimeters without the petiole. It is rounded, auricled, or deeply cordate at the base, with the borders unequally but simply dentate, the short, outside-turned teeth varying in distance, following the relative position of the secondary veins and of their branches, which all enter them. The lateral veins are thick, the lower ones opposite and somewhat more distant from the first pair of veins above, as these are from the following ones in ascending. Comparing our figure with that of Heer (*loc. cit.*, pl. xlvi, fig. 5), the remarkable affinity of those leaves appears striking. Their size, their form, and their nervation are the same. They merely differ in the character of the teeth, which, pointed along the borders of the American leaf, are obtuse and more prominent, in that of Greenland. But this difference is negatived by Prof. Heer, who, in his description of the specimens from Spitzbergen, which he refers to this species, and which have the borders of the leaves cut in short, acute teeth, remarks (p. 57, *loc. cit.*) that the smaller teeth cannot separate this form from that of Greenland. The locality, Carbon, where a number of Arctic and Alaskan species have been found, renders more probable the specific relation of this leaf to those described under this name from Greenland. We have the same kind also from the Miocene of Roach Hill, Oregon.

Considering its relation, our leaf, as far as it is known, has the same degree of affinity to *Viburnum platanoides*, Lesqx. (pl. xxxviii, fig. 8), as the former described leaves of *Quercus Viburnifolia* have with *V. marginatum;* supposing, however, that the upper destroyed part of the specimen is rounded or abruptly pointed, as the direction and the thinning of the upper secondary nerves seem to indicate, and not lengthened and lanceolate, as it is in fig. 6 of pl. xi of Heer (*loc. cit.*).

HABITAT.—Carbon, Wyoming, with *Populus Arctica*, *Paliurus*, *Colombi*, etc.

§ III.—*Leaves lobate; borders entire.*

Quercus negundoides, Lesqx.

Plate XXI, Fig. 2.

Quercus negundoides, Lesqx., Annual Report, 1871, p. 292.

Leaf coriaceous, short-petioled, cordate at the base, enlarging upward to the three-fourths of its length, where it is palmately cut in three short lobes, the middle taper-pointed, the lateral ones shorter and obtuse; lateral veins seven pairs, equidistant, parallel, craspedodrome.

This peculiar leaf has no relation to any fossil one known to me. Its appearance is that of some *Acer*, or of some deformed leaf of *Ulmaceæ* or *Betulaceæ.* I referred it to *Quercus* on account of its thick consistence and of a distant likeness to *Q. fagifolia* and *Q. triangularis,* Goepp. The leaf is five centimeters long and three and a half broad in its widest part, under the point of the lateral lobes; the petiole is slender, seven millimeters long; the borders entire, slightly irregularly undulate, and the secondary veins all simple, and at an angle of divergence of 40°, except the lower pair, which is basilar, slightly more open, with a few branches on the lower side.

HABITAT.—Evanston, Wyoming, in shale under the main coal (*Dr. F. V. Hayden*).

Quercus angustiloba, Al. Br.

Plate XXI, Figs. 4, 5.

Quercus angustiloba, Ludw., Palæont., viii, p. 103, pl. xxxvi, fig. 3.—Heer, Braunk. Pfl. v. Boernst., p. 14, pl. 1, fig. 8.—Lesqx., Annual Report, 1872, p. 378.

Leaves coriaceous, oblong-lanceolate in outline, narrowed to the petiole, deeply cut on each side into two opposite, linear, obtusely-pointed, narrow, entire lobes, and a terminal one of the same size and form.

This species is positively identified by the two specimens we have figured here, which, though fragmentary, are more complete than those known from the Oligocene of Europe. The leaves, varying in length between seven and fourteen centimeters, are deeply cut on each side in two oblique linear entire lobes, lanceolate to the point, the lowest four to six centimeters long and about one centimeter broad, with obtuse sinuses. The middle or terminal lobe is broken above its base, but is apparently as long as the lateral ones. The secondary veins are scarcely distinct and the areolation totally obsolete. The consistence of the leaves is evidently thick.

HABITAT.—Golden, Colorado, where I found the specimen represented in fig. 4. The other was discovered at the same locality by *Prof. F. B. Meek.*

DRYOPHYLLUM, Debey.

Leaves lanceolate, oblong or linear-oblong, generally dentate, rarely entire, penninerve; secondary nerves (in dentate leaves) subopposite, numerous, parallel, more or less curved, subcamptodrome, forking near the borders; (in entire leaves), camptodrome; nervilles transversely decurrent, simple or forking, joined by branchlets in opposite direction (Sap.).

This definition by Saporta is translated from Pal. Végét, ii, p. 613. Schimper adds that this type, which originates in the Cretaceous epoch, appears to have been the precursor of *Quercus*, *Castanea*, and *Castaneopsis;* that his leaves unite the characters of some *Quercus* and *Castanea* species now living in the Lebanon, the Himalaya, and the mountains of Mexico. He adds that it is regrettable that the species of the Upper Cretaceous of Aix la Chapelle, from which this genus has been established by M. Debey, have not been described to the present time, as they could throw some light on the true place which they take in the vegetable world. In considering the geological distribution of the species of *Quercus*, I have already remarked that I am as yet unable to discern any sufficient character for authorizing a general separation of the leaves described as *Dryophyllum.* I have, however, preserved this section in deference to the authority of European writers, submitting to their wider experience and more judicious discrimination.

Dryophyllum (Quercus) crenatum, Lesqx.

Plate LXII, Figs. 10 and 11.

Dryophyllum crenatum, Lesqx., Annual Report, 1874, p. 301.

Leaf subcoriaceous, oblong-lanceolate, obliquely truncate to the base; borders deeply, regularly undulate or broadly crenate-dentate; lateral veins thick, subcamptodrome; nervilles thick in right angle to the nerves.

The substance of these leaves is somewhat thick, and their surface coarsely marked by the nervation. As far as can be seen from the two fragments obtained, the leaves are of medium size, linear-oblong, either equally undulate on the borders or dentate, with obtuse, broad, short teeth. The secondary veins are thick, flat, entering the teeth or reaching the borders by their ends, while a fork under the teeth or quite near the borders follows them as a camptodrome division, anastomosing with the nervilles. The subdivision of these in the middle of the areas is mostly in right angle, forming ultimately small square or indistinctly polygonal meshes. The midrib is flat and broad. The relation of this leaf is evidently to the Cretaceous *D. latifolium*, Lesqx. (Annual Report, 1874, p. 340, pl. vi, fig. 1).

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Dryophyllum (Quercus) subfalcatum, Lesqx.

Plate LXIII, Fig. 10.

Dryophyllum subfalcatum, Lesqx., Annual Report, 1874, p. 301.

Leaf subcoriaceous, linear-lanceolate, narrowly taper-pointed; borders regularly serrate, with short blunt teeth turned upward; lateral veins very oblique, close, parallel, straight to the point of the teeth.

We have only a fragmentary specimen of this species, the upper half of a leaf, which, by its form and nervation, seems at first referable to the genus *Castanea* or to some variety of the Chestnut-oaks. The nervation is of the same character as in the former species, however, the upper branch of the secondary veins passing from near the point of the veins under the sinuses and closely following the borders, anastomosing with the fibrillæ. These are very close, percurrent, mostly simple, and rarely branching, distinct, though thin.

This species is intimately related to *Dryophyllum Dewalquei*, Sap. and Mer. (Flore de Gelinden), especially to the fragment represented on pl. iii, fig. 2, differing merely by the shorter, less acute teeth of the borders, the slightly falcate form of the leaf, and the close, thin fibrillæ.

HABITAT.—Point of Rocks, Wyoming (*Mr. Wm. Cleburn*).*

CASTANEA, Tournf.

The difficulty of discerning the fossil leaves of this genus from those of *Dryophyllum* or *Quercus* renders uncertain the epoch to which its origin is referable.

One fossil species has been described by Dunker as *Castanea Hausmanni*, from the Cretaceous Quadersandstein of Blankenburg, Hartz, where it is found with leaves of *Credeneria*. On this species, however, Schimper observes that it indeed resembles the leaves of *C. vesca*, the living species so widely distributed in Europe and North America, but that it could just as well belong to *Dryophyllum*. From the Eocene of France, one species is described by Watelet, another is from the Lower Miocene of Southern Europe, and four are distributed in higher stages of the same formation. In this country, leaves of one or perhaps two species of this genus are abundant in the Miocene of Oregon. The fragment published here, and apparently identical with

* To this section of Oaks is referable *Quercus furcinervis*, Rossm., described in Annual Report, 1873, p. 398, from very fine specimens of the Cascade Mountains of Oregon and of the Spanish Mountains of California. The specimens belong to the Geological Survey of this last State, and are figured for its Report.

one of the Oregon species, is from the Upper Miocene of the Parks of Colorado.

It is probable that if the fossil leaves of this kind were known from sufficient specimens, the number of the species would be reduced; for the present flora has only two species: one, *C. vulgaris*, Lam., or *C. vesca*, is represented by a number of marked varieties, often described as species, and distributed over the whole temperate zone of the northern hemisphere, especially along the shores of the Mediterranean Sea in Europe, Western Asia, North Africa, and also in China, Japan, and the United States; the other, *C. pumila*, exclusively belongs to North America.

Castanea intermedia, Lesqx.

Plate XXI, Fig. 7.

Castanea intermedia, Lesqx., Annual Report, 1874, p. 313.

Leaf subcoriaceous, long, narrow, linear-lanceolate, gradually narrowed downward; borders equally sharply serrate; secondary veins slightly curving, open, close, parallel, simple, and craspedodrome.

The fragment represents a leaf, long indeed comparatively to its width, which is not much above two centimeters; while it appears to have been more than twelve centimeters in length. The borders are sharply serrate, the teeth turned upward, thorny-pointed, equal, and each entered by secondary veins, which are simple, close, about four millimeters apart, diverging from the thick midrib at an angle of 50° to 60°. Every trace of areolation is erased. Comparing this leaf to the other fossil species published, it differs from all, being only related by its nervation to *Castanea Ungeri*, Heer (Fl. Foss. Alask., p. 32, pl. vii, fig. 1), and even in our species the lateral veins are still more numerous and more open. It has a more evident likeness to the leaves of our present *Castanea pumila*, from which it would be undistinguishable, but for its linear form and the gradually tapering base. The simple nervation, the degree of divergence of the veins, the form and sharpness of the teeth, are all alike. The common *C. vesca* of the North has longer leaves, more distant veins; but these leaves, at least when young, and especially those of the bushy shoots, are gradually narrowed to the petiole, and linear-lanceolate, like the fossil one. This therefore appears intermediate between both living species of North America.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*).

SALICINEÆ.

SALIX, Linn.

Together with their narrowly lanceolate form, which they have in common with many other plants, the leaves of Willows are recognized by the following characters:—The middle nerve is strong, continued below the base of the leaves into a short petiole; the secondary veins are numerous, close, parallel, generally at an open angle of divergence at or near their point of union to the midrib, more oblique in coming near to the borders, where they unite in continuous festoons by their curved points. These lateral veins are generally intermixed with shorter tertiary ones, whose angle of divergence is often different, and which, branching in the middle of the primary areas, form, by subdivisions in right angle, first, large rectangular areolæ, and then, by multiple nervilles, a net of very small irregular meshes. As said above, the form of these leaves is more generally narrowly lanceolate, more or less rapidly narrowed or rounded to the petiole, but sometimes also broadly elliptical or oblong-ovate, even ovate-subcordate. The borders of the leaves are entire or simply crenate, dentate, or serrate.

The origin of the genus seems legitimately referable to the Cretaceous period. In vol. vi of the Reports of the United States Geological Survey of the Territories, p. 60, pl. v, figs. 1–4, four leaves from the Dakota Group of Nebraska are described and figured as *Salix proteæfolia*, Lesqx., whose reference to the genus is so clearly indicated by the characters of form and nervation that it seems indubitable. Prof. Heer, whose sagacity of determination of fossil leaves is so remarkable, has described, from the same formation, *Salix nervillosa*, a species of a different type of this genus; and Prof. Newberry also has referred to *Salix*, and from the same formation of Nebraska, a number of leaves which he considers as representing four different species. From the European Cretaceous of Blankenburg, Hartz, Dunker has described *Salix Hartigii*, a leaf which, according to Schimper, may belong to a species of *Quercus* of the section of *Q. phellos;* and Heer recognizes a fine species, *Salix Gœtziana*, in the formation of Quedlinburg. These are sufficient authorities in proof of the antiquity of this genus. Schimper remarks, in Pal. Végét., ii, p. 663, that if the attribution of certain saliciform leaves of the Cretaceous formation is correct, we have, in the type of the Willows, one of the most ancient forms of the subdivision of the dicotyledonous Angiosperms.

He adds:—"That some species are also indicated in the Eocene, but they are as uncertain as those of the Cretaceous, and it is only with the first deposits of the Miocene epoch that every kind of doubt is put aside on this question, for then we have not only numerous leaves of which the generic assimilation is indubitable, but also flowers and fruits, which give to the botanists the possibility of determining the subdivisions which had some representatives at that time." It is certain that, according to the remarks of the same author, it is during the Miocene period that the Willows have attained their maximum of specific evolutions. But this extraordinary development of the generic type is sufficient to prove the great antiquity of the genus, if even the presence of numerous leaves, as positively identifiable as those of the Miocene, had not been found in the Cretaceous of both continents. To this we have to add the continuity of the records from the Cretaceous through the Eocene and the Oligocene. Schimper describes fifty-seven fossil species of Willows, two of which are of doubtful generic relation. Adding to this *S. Gœtziana* of the Cretaceous of Quedlinburg, we find twenty-three species referable to the section of dentate leaves. Of these, none is Cretaceous and none is exclusively North American. Four are Eocene, one Oligocene, seventeen Miocene, and one Pliocene or Quaternary. *Salix varians*, common in Europe, has been recognized in the Miocene of Alaska and in the upper divisions of the same formation in California. *S. Lavateri* and *S. macrophylla* are also in the Miocene of Europe and in that of Alaska. Of the thirty-six fossil species of Willows with entire leaves, eight are Cretaceous, six from the American Dakota group, and two from Europe. No Eocene species is known from Europe, but we have in the American formation one Miocene European Willow, *Salix integra*, Goepp., discovered in the Eocene strata of Black Buttes, Wyoming Territory, and one species peculiar to this continent, *S. tabularis*, from the same Eocene formation in the State of Mississippi. *S. angustata*, *S. elongata*, and *S. media* are European and American Miocene species, while two others, *S. Rheana* and *S. Grœnlandica*, belong exclusively as yet to Greenland. An American form, *S. Worthenii*, is from the chalk bluffs of the Mississippi, a Pliocene formation. It is represented as yet by a single leaf, and may be recognized, when other specimens are obtained, as identical with one of our living species.

Salix integra, Goepp.

Plate XXII, Figs. 1, 2.

Salix integra, Goepp., Schoss. Tert. Fl., p. 25, figs. 6, 10, 14.—Lesqx., Annual Report, 1873, p. 397.

Leaves small, entire, oblong, lanceolate-acuminate, gradually narrowed to a short petiole; lateral veins thin, close, intermixed with short tertiary ones; primary areolæ large, quadrate.

The leaves of this species are generally small. Those figured by Goeppert vary from one to four and a half centimeters long and proportionally broad; those described here being therefore of the largest size. The nervation, as seen in figs. 1 and 1 *a*, enlarged, is that of the genus, agreeing entirely with that represented by the European author, especially in fig. 1. The only notable difference of characters is in the more gradually tapering acumen of the American leaf, and this is not of specific value for a species whose leaves are greatly variable in size and form, some of them being obtuse or even half-round at the point, while some others are sharply acuminate or pointed.

From Heer's remarks on this species in Fl. Tert. Helv., iii, p. 175, the leaves represented by Goeppert (*loc. cit.*, figs. 2, 3, 4, 8, 9), with more distant and stronger secondary veins, without intermediate tertiary ones, are referable to *Benzoin attenuatum*, Heer (*loc. cit.*, ii, p. 82, pl. xc, fig. 10), to which he refers also the leaves described in the same volume (p. 32, pl. lxviii, figs. 20–22) as *Salix integra*. We have apparently here the two forms described and figured by Goeppert, one (fig. 1) identical in characters with fig. 1 of the Schossnitz Flora, as remarked above, and one (fig. 2) showing quite as distinctly the characters of fig. 2 of Goeppert's, for it has the secondary veins more distant and no trace of intermediate tertiary veins. The habitat of these leaves being the same, I consider the difference as merely apparent, resulting from the more imperfect state of preservation of the leaf in fig. 2. Specimens from Golden, and also from the Miocene of Oregon, have the same character of nervation, and a short, naked petiole. The typical characters of *Benzoin attenuatum*, viz., the border base decurrent along the petiole, which is therefore winged, and the lower lateral veins at a more acute angle of divergence, and following the borders to the middle of the leaf, as indicated in Heer's *loc. cit.*, pl. xc, fig. 10, are not seen upon any of the American leaves.

HABITAT.—Black Buttes, Wyoming, the two specimens figured here; Golden, Colorado, a more imperfectly preserved one.

Salix media, Heer.

Plate XXII, Fig. 3.

Salix media, Heer, Fl. Tert. Helv., ii, p. 32; iii, p. 175, pl. lxviii, figs. 14-19.—Al. Br., Stizenb. Verz., p. 78.—Ludw., Palæont., viii, p. 93, pl. xxviii, figs. 1-4.—Lesqx., Annual Report, 1871, Supplement, p. 6; 1873, p. 411.

Leaves entire, rounded at the base to a short petiole, linear, lanceolate-pointed, or gradually tapering to the point; secondary veins open, camptodrome.

The figure represents one of two leaves upon the same specimen, the one not figured having the same character, rounded at the base, linear-lanceolate to near the point where it is broken, and without any trace of secondary veins. These are not generally visible upon the upper surface of the leaves. Of those represented by Heer, one only (fig. 16) has its nervation discernible; it is the same with those described by Ludwig. The identity is recognized, however, by the form of the elongated, lanceolate, entire leaves, rounded to the short petiole, a character distinctly marked in all the figures of this species published by European authors, except in Ludwig's *loc. cit.*, fig. 2, which seems referable to another. The specimens from Elko agree also exactly in the same characters, and their secondary nervation is still more obsolete than in those of Green River.

HABITAT.—Green River, Wyoming (*Dr. F. V. Hayden*); Elko Station, Nevada (*Prof. E. D. Cope*).

Salix angusta, Al. Br

Plate XXII, Figs. 4, 5.

Salix angusta, Al. Br., Stizenb. Verz., p. 77.—Heer, Fl. Tert. Helv., p. 30, pl. lxix, figs. 1-11.—Lesqx., Annual Report, 1871, Supplement, p. 6; 1872, p. 405.

Salix angustifolia, Al. Br., in Buckl. Geol., p. 512.

Salix angustissima, Al. Br., in Leonh. und Bronn. Jahrb., 1850, p. 169.—Ung., Gen. et Sp., p. 418.

Leaves entire, generally very long, and comparatively narrow, at least twelve times longer than broad, linear-lanceolate, gradually tapering upward to a long acumen and downward to a short petiole; middle nerve thick; secondary veins close, numerous, more distinct than in the former species.

This species essentially differs from the former by narrower, much longer leaves, either gradually narrowed to the point and to the petiole, or linear, with borders nearly parallel in the middle, tapering into a long point, and more abruptly rounded to the petiole; the middle nerve is broader, and the secondary veins more distinct, in a more acute angle of divergence. The size of these leaves is very variable, at least for the length, one of our fragments exposing a leaf of about fourteen centimeters long, while the other specimen is of a leaf preserved entire, and measuring only six and a half centimeters, though scarcely broader. Another specimen of the same species and from

the same locality has only one-half of a leaf, also of the same width, twelve millimeters broad in the middle, showing the under part, with secondary veins distinctly marked, like their divisions, and the surface evidently villous, or bearing the impression of a coating of hairs Prof. Heer, in his description of this species, compares it to *S. viminalis*, Linn., a living and common species of this country, remarking, however, that the specimens do not indicate whether the leaves are villous, as in the living species. This villosity is not apparent upon well-preserved specimens received from Oregon.

HABITAT.—Green River Station, Wyoming, above fish beds (*Dr. F. V. Hayden*). One fragmentary specimen from six miles above Spring Cañon, Montana, appears referable to the same species.

Salix elongata, O. Web.

Plate XXII, Figs. 6, 7.

Salix elongata, O. Web., Palæont., vol. ii (Separ. Abdr.), p. 63, pl. ii, fig. 10.—Heer, Fl. Tert. Helv., ii, p. 31, pl. lxix, figs. 15, 16.—Lesqx., Annual Report, 1872, p. 372.
Salix longissima, Wess. & Web., Palæont, iv (Separ. Abdr.), p. 30, pl. v, fig. 6.

Leaves entire, long, lanceolate, gradually narrowed from the middle toward the point and toward the petiole; middle nerve thin; borders apparently revolute or reflexed; secondary veins open, distant.

The leaves of this species, at least judging from the fragmentary specimens which I refer to it, are larger than those of the former, more distinctly lanceolate and more rapidly tapering to the point, coriaceous, with the veins more distant, irregular in their relative position, and with a very narrow midrib. These fragments have the same characters of form and nervation, as far, at least, as this may be discerned, as the fine leaf described (*loc. cit.*) by the author of this species. The leaves figured by Heer as representing it are, however, narrower, linear-lanceolate, of the same form as those of *Salix longa*, Al. Br., but distinct by the narrow midrib.

HABITAT.—Elko Station, Nevada (*Prof. S. W. Garman*).

POPULUS, Linn.

Represented merely by more or less fragmentary leaves, as it is as yet in our American fossil flora, the genus may be characterized as follows:—

Leaves of various forms; broadly ovate, round or lanceolate, generally cordate or rounded at the base; long-petioled; with borders entire, crenulate or dentate; palmately nerved from the top of the petiole or from a distance above the border base. The primary and secondary nerves are camptodrome, anastomosing outside of the bends with nervilles, either passing directly to

the teeth or divisions of the borders, or curving along them. The areas, divided in right angle by fibrillæ, form primary irregularly square meshes, and the veinlets branching in various directions ultimately constitute a very small polygonal areolation. One pair of slender marginal nerves pass from the top of the petiole below the primary lateral veins, joining their branches by veinlets. These general characters are, however, modified in many ways The nervation, especially, is very variable and complex, for, by the addition of one or two pairs of nerves under the primary one, it becomes five- or seven-palmate, while in other leaves, as for example in those of *Populus balsamifera* var. *angustifolia*, a species especially common in the valleys and along the base of the Rocky Mountains, the lower primary nerves are alternate, of the same thickness as the secondary ones, all equidistant and equally branching underneath, representing thus a pinnate nervation, rendered remarkably similar to that of the leaves of *Salix* by the interposition of short tertiary veins, traversing the lower side of the areas and dissolving in their middle by subdivision in nervilles. In other cases, as in the so multiform leaves of *Populus alba*, an introduced species, too common in this country, the primary lateral nerves, two or three pairs, stronger and more branching than the secondary ones, go straight to the points of acute lobes or of larger teeth formed by expansion of the laminæ, are thus craspedodrome, as well as some of the secondary ones, and give to the leaves some of the characters and the appearance of leaves of *Platanus*.

These variations in the characters of the leaves, even of the same species, render their determination very difficult and somewhat unreliable; for the paleontologist has rarely for examination and study a series of specimens so numerous, and in such a perfect state of preservation, as are those which have served for the preparation of the admirable monograph of this genus in Heer's Fl. Tert. Helv., where are represented branches bearing leaves of various forms, some entire, some dentate, besides buds, bracts, catkins of flowers, and seeds.

The difficulty of determination of the leaves of *Populus* may, in a certain degree at least, account for the great difference between the number of species of this genus known as living at our time, eighteen only,* and the fossil ones, of which Schimper's Pal. Végét. describes sixty-two, considering, however, nineteen of them as doubtful Of the species of Poplars living at our

* According to the monograph of Wesmael, in De Candolle's Prodromus.

time, the North American continent has the largest number, nine, mostly inhabiting the cold and mountainous regions. Some, however, have a wide range of distribution: *Populus tremuloides*, Michx., and *P. Canadensis*, Desf., for example, extend between the Pacific and the Atlantic from Canada to Louisiana and New Mexico. One species, *P. Mexicana*, Wesm., is peculiar to Mexico, descending as far south as Tampico. Another, *P. trichocarpa*, Torr. & Gray, is limited to California. Three species are common to Europe and Asia; even one of them, *P. alba*, L., has been found in Algeria. China has two species, Japan one, and three belong to the Orient.

Considering the fossil species, and leaving out those which have been separated as doubtful, we find described in Schimper's synopsis forty-two, of which two only are Cretaceous: *Populus litigiosa*, Heer, and *P. elegans*, Lesqx., both from the Dakota group. To these we should add, though not mentioned in the synopsis, *P. cyclophylla*, Lesqx., and *P. Lancastriensis*, Lesqx., from the same formation, with *P. hyperborea*, Heer, *P. Berggreni*, Heer, from the Upper Cretaceous of Greenland, and *P. primæva*, Heer, from the Lower Cretaceous of the same country. Dr. Newberry has described, in his notes on the later extinct floras, four species, two of which are considered by himself as doubtfully referable to this genus; another, *P. microphylla*, is of uncertain relation, and the fourth, *P. elliptica*, of a Miocene type, seems to have been referred to the Cretaceous by a mistake caused by misplacement of labels or of specimens. Though it may be that we have already seven Cretaceous species of *Populus*, one of which, *P. primæva*, represents, by leaves and scales of seeds, the only dicotyledonous plant found in the flora of Comes, a Greenland Lower Cretaceous flora, composed of seventy-five species of *Filices*, *Selagineæ*, *Cycadeæ*, *Coniferæ*, and a few monocotyledonous, mostly of Jurassic or Wealden types: this *Populus* is thus the oldest dicotyledonous plant known as yet. From this, we cannot be surprised to find the generic type already preponderant at a higher stage of the Cretaceous, that of the Dakota group, whose flora is composed mostly of dicotyledonous plants. No species of *Populus*, however, has been described to this time from the Cretaceous of Europe. This is a remarkable fact, rendered more striking by the scarcity of representatives of the same genus in the Eocene of that continent, which has until now only two species, both from the lower members of the formation, Sézanne and Belleu. Besides five Tertiary species described by Dr. Newberry from the Fort Union and Yellowstone Lignitic, and which may be Eocene,

we have six others, positively referable to this formation, one of which is from Vancouver, two are common to the Mississippi and the Colorado Lignitic, and two have been obtained from the lowest Tertiary strata of Point of Rocks, which immediately rest upon the Cretaceous, and whose flora still preserves a few representatives of Cretaceous types. In the Miocene of Europe, however, the genus takes a large predominance, twenty-eight species being there described from this formation. To the present time, we have only ten; but considering the number of Tertiary species known from both continents, this indicates about the same proportion in the geological distribution. Seven of the American Miocene species are common with Europe; and, of these, three are also found in Alaska They represent especially the Middle Miocene, predominant in Oregon, and on the eastern side of the Rocky Mountains, especially at Carbon, a division from which comparatively few materials have been obtained until now. As remarked in the descriptions of the species, the relation of some of them to types of the present flora of this country is distinctly recognized.

§ I.—*Marginatæ.*

Populus latior, Al. Br., var. **cordifolia.**

Plate XXII, Fig. 8.

Populus latior cordifolia, Heer, Fl. Tert. Helv., p. 12, pl. lv.—Ludw., Palæont., viii, p. 91, pl. xxvi, fig. 7.—Lesqx., Annual Report, 1871, pp. 287, 289.

Leaves nearly round, broadei than long, short-pointed, subtruncate at base, wavy-margined; primary veins three, camptodrome.

The form of this leaf and the characters of the borders are referable to those described by Heer, and the nervation, somewhat abnormal by the absence of one of the primary nerves joining the midrib a little above the border base, is comparable to that of the leaf figured by Ludwig. The upper part of the leaf is destroyed. But another specimen, whose nervation is not quite as distinct, described in the same Report, p. 287, as *Populus latior* var. *transversa*, Heer, represents a smaller, short-pointed leaf, with more deeply marked undulations of the borders, which is apparently referable to the same variety.

HABITAT.—Washakie Station, Wyoming (*Dr. F. V. Hayden*).

Populus subrotundata, Lesqx

Plate XXIV, Figs. 6–8.

Populus subrotunda, Lesqx., Annual Report, 1867, p. 196.—Schp., Pal. Végét., ii, p. 686.
Populus attenuata, Al. Br., Lesqx., Annual Report, 1872, pp. 386, 389, 392.

Leaves long-petioled, nearly round, as broad as long, subtruncate at the base, abruptly pointed, acutely dentate; nervation tripalmate, camptodrome.

The first of these leaves (fig. 8) was considered as representing a new species, distinct from *P. attenuata*, Al. Br., especially by the sharp, turned-up teeth of the borders and the more abruptly narrowed or truncate base. It has, however, a great likeness to the figure given of this last species in Heer (Fl. Tert. Helv., pl. lviii, fig. 1). The examination of other specimens from Carbon, though more fragmentary, confirms the first opinion in regard to the specific difference. The primary lateral veins separate from the midrib a little above the base, being much branched underneath and comparatively thick; the secondary ones are somewhat higher up, mostly simple, and the areas are cut by nervilles in right angle to the veins. These characters are identical with those of *P. attenuata;* but the round shape of these leaves is different and the teeth always more acute than in the European species. This form is related to the North American *Populus monilifera*, Ait.

HABITAT.—Rock Creek, Laramie Plains, Wyoming (*Dr. F. V. Hayden*); Carbon, Wyoming, where it is not rare, and found in both the beds of shale above and below the main coal. The specimen in fig. 7 is from Evanston, Wyoming, procured by *Dr. Hayden*

Populus melanaria, Heer

Plate LXIV, Fig. 5.

Populus melanaria, Heer, Fl. Tert. Helv., ii, p. 16, pl. liv, fig. 7; lvii, fig. 1.—Lesqx., Annual Report, 1874, p. 302.

Leaves with a long, slender petiole, broadly deltoid or subtruncate at the base; borders acutely serrate; primary lateral nerves emerging from a distance above the base of the leaves, with a pair of marginal veinlets underneath.

This leaf, considering what can be seen of it by the fragment, which represents merely its lower half with the long slender petiole, the distinct nervation, and a few of the border teeth, exhibits characters in accordance with those described above, and translated from Schimper's Pal. Végét., ii, p. 684. It agrees especially with the fig. 7 of Heer, *loc. cit.* This author remarks that the species essentially differs from *Populus latior* var. *subtruncata* by the position of the lateral primary nerves at a distance from the

border base of the leaves. In our specimens, as seen in the figure, the distance is still greater than in that of the Fl. Tert. Helv. Prof. Heer remarks also that he has had for examination a large number of specimens of the same species, but that in all, except one, which he has figured, the upper part of the leaves is destroyed, as it is in ours. He mentions, as distinctive characters, the acutely serrate borders of the leaves, and the middle nerve thicker than the lateral ones, the same as seen upon our specimen. I believe, therefore, that the identification of this leaf with the European species is fully authorized. Heer considers this species as allied to the living *P. dilatata*, Ait., and *P. nigra*, Linn.

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Populus melanarioides, Lesqx.

Plate LXII, Fig. 5.

Populus melanarioides, Lesqx., Annual Report, 1874, p. 302.

Leaves long-petioled, subcoriaceous, nearly round, subtruncate at base; borders entire, undulate; nervation ternate from above the base; secondary veins, two pairs, at a great distance from the primary ones, these much branched outside, the others simple; divisions passing to near the borders or entering them.

By its subcoriaceous substance and the long petiole of the leaves, this species is related to the section of the *Trepidæ* (Trembling Poplars). As in *Populus tremulæfolia*, Sap. (Ét., 3, 2, p. 26, pl. iii, fig. 4), to which our species is allied, the veins and their branches pass through the areas to very near the inflated borders, which they seem to reach, but along which they are really curved. Our leaf differs from those of this last species merely by less distinctly undulate borders, by the higher position of the primary lateral veins above the base, and by the great distance of the secondary less numerous veins. These two last characters are, however, of no moment in the specification of Poplar leaves, as can be seen in the examination of a few specimens of *Populus alba*. In fossil species, also, as in *P. Massiliensis*, Sap. (Ét., 3, 2, p. 30, pl. ii, figs. 6–8), the three leaves which represent it have each a different type of nervation. The relation of our leaf to that described by Saporta from the Tertiary of Provence may be therefore more intimate than it appears from the comparison of a single leaf. It is also comparable to *Populus heliadum*, Ung., by its form, and to *P. melanaria*, Heer, by its nervation.

HABITAT.—Point of Rocks, Wyoming (*Wm. Cleburn*).

§ II.—*Trepidæ.*

Populus Ungeri, sp. nov.

Plate XXIV, Fig. 5.

Populus heliadum, Ung., Lesqx., Annual Report, 1873, p. 397.

Leaves subcoriaceous, long-petioled, broadly ovate, obtuse; borders entire, slightly undulate; secondary veins equidistant with the primary ones.

This leaf, rather membranaceous than coriaceous, with a slender, apparently long, petiole, has the form of *Populus mutabilis repando-crenata*, Heer, as represented in Fl. Tert. Helv., pl. lxii, fig. 1, and the nervation of *P. balsamoides*, Goepp., as in pl. lx, fig 2, of the same work; the primary lateral veins and the secondary ones being equidistant, and of the same thickness. From the first of these species it differs by the nervation; from the second, by the entire borders of the leaves. From *P. heliadum*, Ung. (Fl. v. Sotzka, p. 37, pl. xv, fig. 7), to which I referred it formerly, it differs equally by the more numerous equidistant nerves, the less enlarged form of the leaf, and the borders less distinctly undulate, Unger describing them as undulate-dentate. Other specimens may indicate a more positive relation. Except for its slender long petiole and an apparently merely membranaceous or thin consistence, this species should go to the section of the Coriaceous Poplars, and be perhaps referred to *P. monodon*, represented in figs. 1 and 2 of the same plate.

HABITAT.—Golden, Colorado.

§ III.—*Balsamitæ.*

Populus lævigata, Lesqx.

Plate XXII, Fig. 9.

Populus lævigata, Lesqx., Annual Report, 1869, p. 195.
Populus æqualis, Schp.,* Pal. Végét., p. 693.

Leaves large, cordate, acuminate, rounded to the base, dentate; teeth acute, turned outside; midrib much thicker than the lateral ones; surface smooth or polished.

This fine leaf, thirteen centimeters long, and eleven centimeters wide a little below the middle, is so closely allied to *Populus balsamoides*, Goepp., extensively distributed in the European Miocene, that it can only be separated by the form of the teeth of the borders. The size of the leaf is equaled by that of some of those published by the authors as pertaining to *P. balsamoides;* the middle nerve is in both species comparatively thick; the general nervation and the areolation are the same. Many fragments seemingly

* The name *Populus æqualis* mentioned was originally sent to Prof. Schimper with a photographed figure of the specimen, and changed afterward without knowing that he had described the species.

referable to *P. balsamoides* have been found in different parts of the North American Lignitic formations, at Golden, Black Buttes especially; one also is from Mount Diablo, California; but these fragments are all too insufficient for positive identification; and the difference in their stations seems to contradict an identity with the Miocene species. Good specimens of *P. balsamoides* have been, however, procured from the Miocene of Coral Hollow, California, and have been figured for the Fossil Tertiary Flora of that State. Heer has described it from specimens of Alaska.

HABITAT.—Rock Creek, Laramie Plains, Wyoming (*Dr. F. V. Hayden*).

Populus Zaddachi, Heer.

Plate XXII, Fig. 13.

Populus Zaddachi, Heer, Fl. Foss. Arct., i, p. 98, pl. vi, figs. 1–4; xv, fig. 1*b*; ii, p. 468, pl. xliii, fig. 15; xliv, fig. 6; Fl. Foss. Alask., p. 26, pl. ii, fig. 5*a*; Spitz. Mioc. Fl., p. 55, pl. ii, fig. 13*c*; x, fig. 1; xi, fig. 8*a*; Mioc. Balt. Fl., p. 30, pl. v, vi, figs. 1–7; xii, fig. 1*c*.—Lesqx., Annual Report, 1871, p. 292.

Leaves ovate, obtuse, rounded or subcordate at the base, crenate, palmately five-nerved; upper primary lateral nerves at an acute angle of divergence, ascending to above the middle of the leaves.

This species, very common in the Miocene of the Baltic, of Greenland, and of Alaska, has, until now, few representatives in this country and none in the Lower Lignitic. It is found with the following species in the Upper Tertiary measures, especially abundant in the Pliocene of California. By comparison, it will be seen that our leaf has exactly the characters of those figured in Fl. Balt., pl. v, figs. 2 and 5, the lower lateral veins being effaced and very short, and the base of the leaf being rounded in narrowing to the petiole. The general nervation is also the same, the primary upper lateral nerves being much thinner than the midrib, indeed, of the same size as the secondary ones, which are at a comparatively great distance from the basilar nerves and at a much more open angle of divergence. The teeth of the borders are of the same form, obtuse or half-round, turned upward. The size of the leaves of this species is very variable; ours measures six centimeters long and nearly five centimeters broad. Heer figures one from the Baltic Miocene, sixteen centimeters long and twelve centimeters broad.

HABITAT.—Green River Station, Wyoming, above fish beds (*Dr. F. V. Hayden*).

Populus Richardsoni, Heer.

Plate XXII, Figs. 10–12.

Populus Richardsoni, Heer, Fl. Foss. Arct., i, p. 98, pl. iv, figs. 1–5; vi, figs. 7, 8; xv, fig. 1 *c*; ii, p. 468, pl. xliv, figs. 7–9; lv, fig. 3 *b*; Spitzb. Mioc. Fl., p. 54, pl. x, figs. 8–12.—Lesqx., Annual Report, 1873, p. 411.

Leaves broadly ovate or nearly round, truncate or slightly emarginate at the base, deeply irregularly crenate, palmately five-nerved; primary lateral nerves about as thick as the midrib, the upper ones at an acute angle of divergence, ascending to near the point, branching in right angle or in a broad angle of divergence.

As recognized from European specimens, the leaves of this species are very variable in size, mostly broadly oval or round, even broader than long, with their borders deeply cut in irregular round teeth, a character which is clearly defined in figs. 11 and 12 of our plate. They are described as acuminate, and appear to be so in two figures of the author; but, in others, they are evidently obtuse, a character remarked upon the leaf of our fig. 12. There is a great difference in the relative position of the primary lateral nerves, which generally come out from the top of the petiole, as in fig. 10, but which in fig. 11 become distant, the internal ones being far above the base of the lamina and of the lower ones. That this difference is unimportant for specification is evidenced by the nervation of the leaf in fig. 12, whose basilar nervation is intermediate between that of the two others. This species is, by its characters and its habitat, closely allied to the former. It is one of the most common of the Arctic Regions, but has not been found either in the Baltic or the Alaska Miocene.

HABITAT.—Elko Station, Nevada (*Prof. E. D. Cope*). It is represented in the collection by six specimens, being therefore abundant at the locality.

§ IV.—*Coriaceæ.*

Populus mutabilis, var. f. ovalis, Heer.

Plate XXIV, Figs. 3, 4.

Populus mutabilis f. *ovalis?*, Heer, Fl. Tert. Helv., ii, p. 22; i, pl. i, figs. 1, 2; ii, figs. 2 *a*, *b*; ii, pl. lx, fig. 12 *b*; lxi, figs. 1–3, 6, 9; lxiii, fig. 4.—Lesqx., Annual Report, 1871, p. 292; 1872, pp. 401, 405; 1873, p. 397.

Leaves coriaceous, long, petiolate, oval, pointed, narrowed or rounded to the petiole; borders entire; nervation three- or five-palmate.

The references to the descriptions in the reports apply to different varieties of this species, some of which have not been figured, on account of the deficiency of the specimens, or from their exposition upon large rocks which could not be displaced or broken. These varieties are so numerous

and so intimately allied by their characters that it is extremely hazardous to identify single leaves with one of the eight subdivisions of this species in Heer's monograph. The first of our leaves (fig. 3) is subcoriaceous, entire, oval, obtusely pointed, and narrowed to the long slender petiole in the same degree as to the point. The nervation is three-palmate from above the base, obscure, indeed; for the lateral primary nerves, narrower than the midrib, are, as well as the secondary ones, scarcely discernible. For its shape and nervation, it is like the leaves in Heer (*loc. cit.*, pl. i, fig. 1, and pl. ii, fig. 2 *b*). The other leaf, more distinctly coriaceous, is lanceolate, gradually enlarged toward the base, and rounded to the petiole; the borders are entire, and the nervation, five-palmate from above the base, is quite distinct and has the characters of Poplar leaves. The shape is, however, different from any of the leaves figured by Heer, its nearest affinity being with fig. 12 *b* of pl. lx and fig. 1 of pl. lxi. This leaf therefore may represent a new species of the division of the *Coriaceæ*. A very fine specimen of the var. e. *repando-crenata*, Heer, a leaf fully preserved, sixteen centimeters long, without the eight centimeters long petiole, and eight centimeters broad toward its round truncate base, was exposed at Evanston upon a block of sandstone prepared for building. I could only make a sketch of it, and by comparison found it perfectly similar to the fine leaf in Heer (*loc. cit.*, pl. lxii, fig. 4). Other fragments were recognized imbedded with bones of the Saurian at Black Buttes.

HABITAT.—Evanston, Utah, as represented in fig. 3. Six miles above Spring Cañon, Montana, the leaf of fig. 4 (*Dr. A. C. Peale*). Black Buttes, Wyoming, etc.

Populus arctica, Heer.

Plate XXIII, Figs. 1-6.

Populus arctica, Heer, Fl. Foss. Arct., i, pp. 100, 137, 158, pl. iv, figs. 6 *a*, 7; v, vi, figs. 5, 6; viii, figs. 5, 6; xvii, figs. 5 *b*, *e*; xxi, figs. 14, 15; xxx, fig. 9; ii, p. 468, pl. xliii, fig. 15 *a*; liii, fig. 4; Spitz. Mioc. Fl., p. 55, pl. x, figs. 2–7; xi, fig. 1; xii, fig. 6 *c*.—Lesqx., Annual Report, 1871, pp. 289, 300; Supplement, p. 9; 1872, pp. 385, 401; 1873, p. 406.

Leaves thickish or coriaceous, round-oblong, or sometimes enlarged in the middle, and broader than long, abruptly short-pointed, narrowed or truncate to the petiole; borders entire, undulate or crenate; nervation five-palmate from the top of the petiole; upper primary nerves as thick as the midrib, much branching outside, passing up in an acute angle of divergence and curving inside toward the point of the leaves; secondary veins thinner, and distinct from the primary ones.

Comparing the figures which represent this species, it is evident that their characters, however different they may be, all agree with those of the leaves described by Heer under this name. Fig. 1 and fig. 3, two leaves of the same size and of the same form, enlarged in the middle, about seven

centimeters long and as broad, with entire borders, a truncate or rounded base, abruptly short-pointed, seem like a copy of pl. v, fig. 3, of Heer (*loc. cit.*). This is only a little larger, but the nervation is exactly the same. Our fig. 3 has the borders entire, not even undulate, but the same character is clearly marked upon the leaf of pl. xxi, fig. 14, of the Arctic Flora. The transition from our fig. 3, a leaf broadly cuneate, to fig. 5, narrowed to the base, is indicated by the intermediate form of fig. 4, and the leaf of fig. 6, with crenate borders, finds its typical analogy in that of pl. xxi, fig. 15, of Heer, an analogy indicated also by the habitat, as the leaves from Troublesome Creek, represented in figs. 3 and 6, are mixed with other intermediate forms upon the same specimen. It is well, however, to remark the similarity of this last figure with that of *P. paleomelas*, Sap. (Ét., ii, 2, p. 123, pl. 7, fig. 10), which differs only by the primary nerves being more slender, not curving inside, and the secondary veins descending lower. The small leaf of fig. 2 is comparable to those of the following species, but it has the strong, distinct nervation of *P. arctica*, represented in the Arctic Flora by leaves still much smaller than this, and also the peculiar, wrinkled, somewhat shining surface of the species.

HABITAT.—Troublesome Creek, Colorado, *Mr. Mitchell*, who collected from the locality twelve specimens only, half of which represent this species, the others *Platanus affinis*. Carbon, Wyoming, where the species is common with *Acer*, *Platanus aceroides*, etc. Green River, Wyoming, with species of *Ficus* of Miocene character. Though abundant in Greenland and Spitzbergen, it is not described from Alaska. It has not been seen until now in the specimens from Oregon and of California.

Populus decipiens, Lesqx.

Plate XXIII, Figs. 7–11.

Populus decipiens, Lesqx., Annual Report, 1872, p. 385.—Schp., Pal. Végét., iii, p. 590.

Leaves small, coriaceous, entire, broadly rhomboidal, deltoid to the point, and also to the long, slender petiole, palmately three- or five-nerved from the base.

The numerous leaves seen of this species have all the same characters. They are small, as broad as long, varying in size from one and a half to four centimeters long without the petiole, which is very slender, and as long as the lamina, if not longer. Broadly cuneate to the obtuse point, and equally so to the petiole, they are more or less enlarged in the middle; one of the leaves of fig. 9 being four centimeters broad and less than three and a half

centimeters long. The surface is not rugose or crumpled, but rather smooth. The borders are perfectly entire, not even undulate, and the consistence is coriaceous, somewhat less so than in the former species, which it resembles by the shape of the leaves and by the nervation. The primary nerves, however, are much thinner, the nervilles closer, strong, the upper ones passing to secondary nerves, or altogether taking their places, as in the fragment of the left side of fig. 9. In other leaves, however, the distribution of the secondary veins is the same as in *P. arctica*, of which this new species seems to be like a diminutive form. It has also a great similarity to *Paliurus columbi.*, Heer, whose leaves are found both at Carbon and Creston, mixed with those of this *Populus*, and undistinguishable when the petiole is destroyed. This remarkable likeness is seen in comparing for example fig. 10, whose petiole is shorter and thicker than in the other leaves, with figs. 14 and 15 of our pl. l. The identity of habitat and the similarity of characters in these leaves has rendered their separation difficult, and for some of them uncertain.

The relation of these two last species to *Populus* has been controverted, for the reason that no point of comparison is found at our time among living species of Poplars. The shape and nervation of the leaves have some likeness to those of *Cercis*, these of *P. decipiens* resembling for example *C. antiqua*, Sap. (Ét., i, p. 134, pl. xiv, fig. 4 *a*). This attribution is, however, contradicted by the long petiole of both the American Miocene species and by a marked difference in the details of the nervation.

HABITAT.—Creston, Washakie group (*Dr. F. V. Hayden*); Carbon, Wyoming, shale above the main coal, as common there as *P. arctica.*

Populus monodon, Lesqx.

Plate XXIV, Figs. 1, 2.

Populus monodon, Lesqx., Trans. Am. Phil. Soc., vol. xiii, p. 413, pl. xv, figs. 1, 2; Annual Report, 1871, Supplement, p. 13; 1873, p. 375.—Schp., Pal. Végét., ii, p. 699.

Leaves large, coriaceous, entire or undulate, broadly ovate, lanceolate or taper-pointed, rounded to the base; primary nerves basilar.

The two first leaves of this species described from the Mississippi have the borders undulate, one of them being marked by a single obtuse short tooth. This difference, the only one remarked between them and those figured here, is of no specific value. These leaves are large, from eight to sixteen centimeters long, and from six to twelve centimeters broad toward the base, those of the Mississippi being still larger. The very thick midrib, the slender secondary

nerves, numerous, equidistant, parallel, on the same open angle of divergence of 60°, obliquely crossed by very strong nervilles, are common characters to all the specimens of this species. From the position of the lower lateral nerves in our fig. 1, they appear opposite from the base of the leaf, and show a tripalmate nervation. In fig. 2, the lower nerves are alternate, a distribution which, though rare in leaves of *Populus*, is seen, as observed above, in the living *P. balsamifera*, var. *angustifolia*. Therefore, as the consistence of this leaf and its shape are the same as in that of fig. 1, I consider it as representing the same species. This *Populus* is very closely allied to *P. Gaudini* (F. O.), Heer (Fl. Tert. Helv., pl. lxiv), by the form, the size, and the borders of the leaves entire or undulate. The nervation is also of the same type, rendered still more analogous by the absence of one of the primary nerves in Heer's fig. 6, as it is in fig. 2 of our plate. The European *P. Gaudini* differs by the midrib being nearly half narrower, and the leaves abruptly narrowed into a long acumen.

HABITAT.—Raton Mountains, base of Fischer Peak, New Mexico (*Dr. F. V. Hayden*). I found the small leaf of fig. 2 at the same locality.

PLATANEÆ.

PLATANUS, Tour.

Four species only of this genus are known at our epoch. *Platanus occidentalis*, Linn., the Plane-tree, or Buttonwood, as it is generally called, is common in this country, and one of the largest trees of the North American continent. Its habitat, by predilection, is along the rivers of the rich bottom-land fertilized by inundations, where it attains such a size that its trunk measures sometime four feet in diameter, even more, its branches spreading wide around in a kind of wild, irregular fashion peculiar to it, denoting freedom of movement, and strength rather than elegance. Like the pioneer of the western wilderness, it seems uncouth and coarse. Its white bark hangs in patches along its branches, like the shreds of an old tattered garment, but its limbs are sound and healthy, always covered in summer with a profusion of large leaves. Its trunk is often hollow, but the tree is tenacious of life. It defies the attacks of the wild elements, the devastating hurricane, the cold storms of the winter, the tropical heat of the hottest summer days, protecting against the multiple changes of our capricious climate the world of vegetables

sheltered under its branches. In the wide plains barren of trees, it is seen looming far away as a fringe to a distant horizon, inviting the tired and thirsty caravan of the western prairies to a place of rest, where it finds abundance of fuel and water.

All the species of *Platanus* are easily recognized by their leaves, generally of large size, somewhat thick, even coriaceous, especially in a fully ripe state, palmately lobed and three- or five-nerved from above the base of the lamina. These leaves have a strongly marked and a mixed nervation, the primary nerves reaching the point of the lobes, while their divisions, as also the secondary nerves, either end into the points of the teeth or curve along the borders as camptodrome.

Of the four living species, one, *P. orientalis*, Linn., is indigenous in Asia Minor, whence it has passed to Europe, and has there become a favorite as an ornamental tree. If more elegant in the distribution of its branches than *P. occidentalis*, it is also generally of much smaller size. Two other species, *P. lindeniana*, Mart., and *P. Mexicana*, Moric., thrive in the valleys of Mexico; the other, *P. racemosa*, Nutt., belongs to California.

In the Cretaceous of the Dakota group, we find already four well characterized species of this genus, one of which is by its leaves remarkably similar to *P. aceroides* of the Miocene, the ancestor of *P. occidentalis*. Besides these, three other forms have been ascribed to the same genus with less positive evidence. The Cretaceous formations of Europe have, to the present time, no representatives of *Platanus*. Neither in the Cretaceous floras of Greenland, of Quedlinburg, and of Moletin, by Heer, nor in that of Niedershoena, by d'Ettingshausen, do we find any vegetable remains ascribed to the genus. Nor is it mentioned, to my knowledge, in the manuscript notes obtained from Devey and d'Ettingshausen on the dicotyledonous plants of the Cretaceous of Belgium. We find the same difference in passing up to the Eocene formations. In the Lower Lignitic of the Rocky Mountains, this disputed ground where Eocene evidence afforded by vegetable remains is contested by animal paleontology, which points to the Cretaceous, four species of *Platanus* are recognized, one of which, *P. Haydenii*, Newby., is closely allied to our living *P. occidentalis*. The Eocene of Europe has none; at least, no species of this kind is described from the Lower Eocene of Gelinden and of Sézanne, and I do not find any mentioned in the list of the species recognized at Mount Bolca We have to go up to the Upper Miocene of

Oeningen, Lobsau, Aix, etc., to find in Europe the first remains of *Platanus*,—*P. aceroides*, Heer, and *P. Guillelmæ*, Goepp., two species so much alike that they have for a long time been considered as one. In the Upper Lignitic of the Rocky Mountains, we have the same two species in Alaska and at Carbon; and still higher, in the Pliocene of California, there are two more, *P. appendiculata*, Lesqx., which, like *P. lindeniana*, has bifid deciduous stipules, and *P. dissecta*, Lesqx., whose leaves, sometimes three-lobate and less deeply dentate, have a relation to *P. racemosa*. *P. aceroides* being recognized as ancestor of *P. occidentalis*, we find thus in the geological times forms intimately related to those of the present flora of this continent, and therefore a clear historical record of the genus.

Platanus Guillelmæ, Goepp

Plate XXV, Figs. 1, 2, 3.

Platanus Guillelmæ, Goepp., Foss. Fl. v. Schoss., p. 21, pl. xi, figs. 1, 2.—Heer, Fl. Foss. Arct., ii, p. 473, pl. xlvii, xlviii, xlix, figs. 4 *b*, *c*, *d*.—Lesqx., Annual Report, 1871, pp. 289, 290; Supplement, p. 9; Annual Report, 1872, p. 387.*
Platanus Œninghausiana, Goepp., *loc. cit.*, pl. x, fig. 4.
Platanus aceroides, Heer, Fl. Tert. Helv., ii, p. 71, pl. lxxxviii, figs. 13, 14; Fl. Foss. Arct., i, pl. xii.

Leaves membranaceous, subtrilobate, with dentate or undulate borders, subtruncate or rapidly narrowed to a short petiole.

This form has been a long time considered by Heer as a mere variety of *P. aceroides*, Goepp., and is still admitted as such by d'Ettingshausen. Our leaves, as figured in pl. xxv, do not show a clear distinction of the characters which ought to separate the species. As far as our specimens indicate it, it is scarcely possible to admit that they represent two specific forms. Figs. 4 and 5, which I think referable to *P. aceroides*, have the sharp and large teeth of this species; but fig. 4 has the leaves more distinctly cuneate or narrowed to the petiole, and fig. 5 has not any lobes, and these two characters refer them to *P. Guillelmæ*. In the large number of specimens obtained of this type at Carbon, some fragments have still longer, more acute lobes and teeth than these two leaves, and therefore are more positively referable to *P. aceroides*. In the three leaves which represent *P. Guillelmæ*, fig. 3 has the teeth scarcely marked, indeed, like mere undulations; in fig. 2, they are shorter than in fig. 4, but already turned upward, and a slight increase of size and sharpness of teeth and lobes does not seem to be of account for a specific

*The specimens referred to this species from Placière, New Mexico, are too obscure for precise determination. That of Black Buttes, described in Report, 1872, is referable to *Viburnum platanoides*.

character. Though it may be, I have here separated the leaves according to the descriptions and figures of the European authors, without positively recognizing this distinction as legitimate; for *P. aceroides* and *P. Guillelmæ* are both represented by specimens from the same localities. From Goeppert's figures (*loc. cit.*), the leaves are all much smaller than those of our plate, especially than fig. 3. In Heer's, however, fig. 1 of pl. xlvii (*loc. cit.*) is about of the same size as ours.

HABITAT.—Carbon, Wyoming, where it is the most abundant; Washakie Station, Wyoming (*Dr. F. V. Hayden*).

Platanus aceroides, Goepp.

Plate XXV, Figs. 4, 5, 6.

Platanus aceroides, Goepp., Foss. Fl. v. Schoss., p. 21, pl. ix, figs. 1–3.—Heer, Fl. Ter. Helv., ii, p. 71, pl. lxxxvii, lxxxviii, figs. 5–12, 15; Fl. Foss. Arct., i, p. 111, pl. xlvii, fig. 3; p. 138, pl. xxi, fig. 17 *b*; xxiii, figs. 2 *b*, 4; p. 150, pl. xxvi, fig. 5; p. 159, pl. xxxii, figs. 1, 2.—Gaud. & Strozzi, Feuilles Foss., p. 35, pl. v, figs. 4–6, vi, figs. 1–3.—Lesqx., Annual Report, 1869, p. 196; 1871, p. 290; Supplement, p. 11; Annual Report, 1872, pp. 389, 406.
Platanus rugosa, Goepp., *loc. cit.*, p. 20, pl. xi, figs. 3, 4.
Platanus cuneifolia, Goepp., *loc. cit.*, p. 22, pl. xii, fig. 2.
Platanus Œninghausiana, Goepp., *loc. cit.*, p. 20, pl. x, figs. 1–3.
Platanus Ettingshauseni, Mass., ex p. Synops., p. 49 (*pl. cit.*, xvii, fig. 3, xix, fig. 3).
Cissus platanifolia, Ett., Foss. Fl. v. Vien., p. 20, pl. iv, fig. 1.
Quercus platanoides, Goepp., *loc. cit.*, pl. vii, figs. 5, 6.
Quercus rotundata, Goepp., *loc. cit.*, pl. viii, fig. 9.

Leaves palmately trilobate, truncate or round-cordate to the petiole; borders deeply acutely dentate, with unequal teeth turned upward.

As said in the description of the former species, this *Platanus* shows a great variety in the characters of its leaves. It is the same in our living species, which, on the same tree, bear leaves from three to thirty centimeters broad between the lateral lobes, and from four to twenty centimeters long. The length of the petiole is equally variable, from one and a half centimeters to eight; two leaves of the same size, and close to each other, upon the same branch, having the petiole, one five centimeters long, and the other nine. Most of the leaves taken from grown-up trees are three-, more generally five-lobed, with acute divisions, the teeth of the borders being also very acute, generally turned upward, and with the base truncate or broadly cordate. It is only upon the young shoots growing in thickets in the gravelly beds of the rivers that we see leaves scarcely lobate, or not at all, merely with short, irregularly dentate borders. These represent in their outline and general characters the fossil leaves described as *P. Guillelmæ*, the others those of *P. aceroides*. Both species may be therefore considered, in an equal

degree of evidence, as the ancestors of *P. occidentalis*. Small round leaves, without distinct lobes, like our fig. 5, are rarely seen in the living species. It is the form represented by Heer in Fl. Tert. Helv., pl. lxxxviii, fig. 10, as *P. aceroides*. It is also very rare to find in the living state as large leaves as that of our fig. 3, with nearly entire or scarcely dentate borders, all the leaves of *P. occidentalis* resembling this fossil form by their shape, having the base narrowed, wedge-form, and the borders distinctly and sharply dentate. But we have a similar form in Heer (Fl. Foss. Arct., pl. xlvii, fig. 1), referred by the author to *P. Guillelmæ*.

Fig. 6 of our plate represents a separate stipule of a different species. As it is nearly entire or obtusely dentate, it belongs probably to *P. Haydenii*, Newby., whose leaves are generally very large, either trilobate, with lobes directed upward and obtusely dentate, or with merely ovate, simply or doubly dentate leaves, without lobes. Specimens of this species occur in profusion at Golden, and often both forms are represented upon the same block of sandstone.

HABITAT.—Same as the former.

Platanus Raynoldsii, Newby.

Plate XXVI, Figs. 4, 5; Plate XXVII, Figs. 1–3.

Platanus Raynoldsii, Newby., Extinct Fl. of N. Am., p. 69.—Lesqx., Annual Report, 1872, pp. 379, 399.—Schp., Pal. Végét., ii, p. 708.

Var. integrifolia.

Platanus integrifolia, Lesqx., MSS.

Leaves of large size, suborbicular or obscurely triangular in outline, more or less rounded and entire toward the decurrent base, dentate, serrate or undulate, even entire, subcoriaceous.

The author of this species has had for his description a leaf fully preserved, with two short lobes or points below the more elongated terminal one, and with borders coarsely doubly dentate. None of my specimens has the point preserved; the general shape only is surmised from the more or less incomplete fragments, and the denticulation is marked upon all the leaves of pl. xvii, either in sharp or obtuse, small teeth passing above to mere undulations. Though I have no doubt that all these leaves represent the same species, there are some differences, striking enough to warrant the representation of these leaves of ours, which expose characters not recognized in the specimens which were in the possession of Dr. Newberry. This difference is especially in the integrity of the borders of the leaves (pl. xxvi, figs. 4 and 5), a character which has not been recognized to this time in any species of *Platanus*. The nervation of all the forms is perfectly similar. In pl. xxvii, fig. 2, the leaf, dentate at or near the base, is merely undulate in its upper part, and, from the direction and thinning of the primary nerves, it is evidently not lobate, but

merely rounded or pointed; fig. 4 of pl. xxvi has the same form, and the borders are only slightly undulate, while in fig. 5 of the same plate the borders are perfectly entire. Hence, with these distinct modifications of characters exposed to view, it would not be advisable to consider these leaves under different specific names, as I did formerly, before I had opportunity to recognize the variations upon a large number of specimens. The size of the leaves is, like the length of the petiole, as variable as in the other congeners.

HABITAT.—Golden, Colorado, in connection with *P. Haydenii;* the specimen of pl. xxvii, fig. 3, is from the same locality, by *Rev. A. Lakes;* the specimen of pl. lxxvi, fig. 4, is from Black Buttes, Wyoming.

Platanus rhomboidea, Lesqx.

Plate XXVI, Figs. 6, 7.

Platanus rhomboidea, Lesqx., Annual Report, 1873, p. 400.

Leaves membranaceous or subcoriaceous, enlarged upward from a narrowed cuneiform base, obscurely lobed above the middle, entire toward the base, deeply sharply dentate in the upper part; lateral nerves in an acute angle of divergence, parallel.

The substance of these leaves is of the same consistence as in the former species, either membranaceous or subcoriaceous; the shape is rhomboidal in outline, largest at the middle, hence narrowed and entire to the base, broadly lanceolate or subtruncate to the point, and there deeply dentate; the lateral teeth entered by the lateral nerves being a little longer or passing to short acute lobes. From the two only specimens in my possession, the leaves of this species appear comparatively small, from seven to twelve centimeters long and from five to nine broad. The nervation is Platanoidal, but the wedge-shaped base of the leaves does not agree in character with that of *Platanus* leaves, at least in a general point of comparison; for, as I have remarked already, *P. occidentalis* has in some peculiar habitat all its leaves narrowed to the petiole, but dentate to the base, and even a variety of *P. orientalis*, described as *P. cuneata*, Willd., has them cuneate, and often entire downward, in the same manner as our fossil species. The fossil leaves, however, are of a more coriaceous substance.

HABITAT.—Golden, Colorado (*Capt. E. Berthoud, Rev. A. Lakes*).

BALSAMIFLUÆ.

LIQUIDAMBAR, Linn.

The genus is represented in the flora of our epoch by five species. One of them, *Liquidambar styracifluum*, Linn., the North American Sweet Gum,

is a tree of moderate size, with five-palmate, serrulate, dark green leaves, emitting, when bruised, a pleasant fragrance by the exuding of a sweet-scented gum. The species has a wide range of distribution, being most frequent in the southern district of our flora, as marked in Gray's Statistics, even passing above its northern limits and descending to South Florida and Mexico. It has, like *Platanus*, a close relation to an Oriental congener, *Liquidambar orientale*, Mill., indigenous of Asia Minor; two other species, with penninervate leaves, not lobate, inhabit the East Indian region, Java, and China. Another, with tripalmately divided leaves, has been more recently discovered in Japan.

To the present time, no leaves of *Liquidambar* have been recognized in the specimens from the Lignitic of the Rocky Mountains. The genus is, however, represented in the Miocene Flora of Alaska by Heer, p. 25, pl. ii, fig. 7, and in a more recent formation, that of the Chalk Bluffs of California, it has numerous leaves of a species closely allied to the living *L. styracifluum*. I have described as referable to *Liquidambar* some leaves from the Cretaceous deposits of the Dakota group. As they have the borders entire, they typically differ from the genus, as far at least as it is represented at our time, and, therefore, this reference is doubtful. Though it may be of the origin of *Liquidambar*, its presence is positively traced on this continent as far back as the Miocene. Europe has until now two fossil species with serrate leaves from the same formation, and a third, *L. Gœpperti*, Walt., from the Paleocene, whose leaves have the borders entire, bearing to the normal form the same relation as *L. integrifolium*, Lesqx., of the Dakota group.

URTICINEÆ.

ULMACEÆ.

ULMUS, Linn.

The Elm leaves are short-petioled, ovate-acuminate or broadly lanceolate, pointed, doubly acutely dentate or serrate, with a more or less inequilateral base, and a pinnate nervation, of close, deeply marked, secondary veins, ascending at first straight toward the borders, and then curving up, in entering the teeth, as craspedodrome. The species of this genus are at our present time about equally distributed in the northern hemisphere, nine of its eighteen species being Asiatic (four of them in China), four European, and six American. Except *U. Mexicana*, which Liebman found in the western declivities of the Cordilleras, all the American species inhabit the northeastern slope of

this continent; none has been found until now in California and along the North Pacific coast. Their range is especially in the whole area between the great lakes and the gulf shores, except for *U. crassifolia*, Nutt., which is not known north of Arkansas, and *U. floridana*, Chap., limited to Florida.

Considering its geological records, the genus seems of recent origin in this country. The only species described here is from the Upper Miocene of South Park. Three others are known from the Chalk Bluffs or Pliocene of California; but in the Lower Lignitic, even in that of Carbon, no leaves of *Ulmus* have been found until now. One species, however, is described by Heer, from the Miocene of Alaska (*U. plurinervia*, Ung), where it is represented by a single leaf, and another has been found in Oregon. None is recorded from Greenland. Per contra, in Europe, the genus has a number of representatives already in the Lower Eocene; three are described by Saporta, from Sézanne, and twenty-two other species are recorded in Schimper's Pal. Végét., mostly from the Paleocene and the Lower Miocene formations. From all these representatives of old, the present distribution of the genus upon the old continent seems normal. It does not appear to be the same in North America, for while we find in the Pliocene of California three species of Elms, none has been left there in its present flora, and all the American species are now, as remarked above, distributed on the eastern slope. This fact represents only an apparent anomaly; the existence of the Elms in California at the Pliocene epoch proving a persistence over the whole continent of some types locally and more recently destroyed by glacial agency.

Ulmus tenuinervis, Lesqx

Plate XXVI, Figs. 1–3.

Ulmus tenuinervis, Lesqx., Annual Report, 1873, p. 412.

Leaves small, thin, short-petioled, either round and equal, or cordate and inequilateral at the base, lanceolate, gradually acuminate; borders unequally serrate; lateral veins thin, more or less flexuous, and curved in passing up to the borders.

The leaves of this species are comparatively small, averaging six centimeters in length and less than three centimeters in width. Their nervation is thinner, and the direction of the lateral veins less straight or more curved than in any other species of this genus. By the great unequality of some of its leaves and their doubly serrate borders, it is related to *U. Braunii*, Heer, a very common species of the Miocene, whose leaves are also small. But in the European form these are comparatively broader, most generally unequal

at the base, with larger, less mixed teeth, and a longer petiole. Except by the more curved lateral nerves and the simple unequal teeth, these fossil leaves could represent a variety of *Ulmus Americana* like the one growing in Texas, which has small, either equal or inequilateral leaves, round or cordate at the base.

HABITAT.—Near Middle Park, Florissant, Colorado (*Dr. F. V. Hayden*). Castello's Ranch, Colorado (*Capt. E. Berthoud*).

PLANERA, Gmel.

This genus is closely allied to the former. Its only living species, indigenous in the southern part of the United States, has been found by Michaux along the borders of the Lower Ohio River, where it is very rare, more generally inhabiting the swampy bottoms of Georgia, Florida, etc. This species, *Planera aquatica*, Gmel., is a small tree resembling *Carpinus*, bearing along its branches small, ovate-pointed, unequally serrate leaves, distichous, and penninerved, like those of *Ulmus*. The genus is recognized in the Miocene of Europe in two species, one of which, *P. Ungeri*, Ett., is very common and variable. In the geological formations of this continent we have already three species, one in the Middle Miocene, *Pl. microphylla*, Newby., the others described below in the upper stages of the same formation. I have, besides, mentioned from Bellingham Bay, *P. dubia*, Lesqx. (Am. Journ. Sci. and Arts, vol. xxvii, p. 361), probably a small form of *P. Ungeri*, and discovered leaves referable to the living species (*P. aquatica*) in the chalk banks, Pliocene, of the Mississippi River, as remarked in the same volume, p. 365. We may therefore follow the distribution of *Planera* from the Vancouver Eocene and the Fort Union Miocene, as indicated by Dr. Newberry, without interruption, to our time.

Planera longifolia, Lesqx.

Plate XXVII, Figs. 4–6.

Planera longifolia, Lesqx., Annual Report, 1872, p. 371; 1873, p. 413.—Schp. Pal. Végét., iii, p. 592.

Leaves small, comparatively thick, oblong, lanceolate, obtusely pointed, cuneate to the petiole, simply obtusely dentate; lateral veins thick, simple, craspedodrome.

The species is represented by a large number of specimens, all with the same characters. The leaves vary in size from two and a half to four and a half centimeters long without the petiole (five to eight millimeters long) and from nine to eighteen millimeters broad in the middle. Fig. 5 represents the broadest of all the leaves seen as yet. They are oblong, obtusely pointed,

the borders marked by large, blunt teeth, whose upper marginal line is horizontal, and thus scarcely turned upward. These characters, as also the narrower shape of the leaves, always equilateral at the base, and their thicker consistence, seem to constantly and positively separate this species from the following one. There is also a marked difference in the more straight direction of the secondary nerves at the same, and generally more acute angle of divergence, 40° to 45°, entering the teeth without curving upward, and somewhat thicker.

HABITAT.—Elko Station, Nevada (*Prof. S. W. Garman*). Castello's Ranch, Colorado (*Dr. F. V. Hayden*, *Prof. E. D. Cope*). Found there in profusion. Mouth of White River, Utah (*Prof. W. Denton*).

Planera Ungeri, Ett.

Plate XXVII, Fig. 7.

Planera Ungeri, Ett., Foss. Fl. v. Vien., p. 14, pl. ii, figs. 5–18.—Heer, Fl. Tert. Helv., ii, p. 60, pl. lxxx; Fl. Foss. Arct., p. 110, pl. ix, fig. 14 *b*; Fl. Alask., p. 34, pl. v, fig. 2.—Ett., Foss. Fl. v. Här., p. 40, pl. x, figs. 4, 5.—Ung., Foss. Fl. v. Kumi, p. 24, pl. iv, figs. 10–16.—Sap., Ét., iii, 1, p. 72.—Sism., Mater., p. 48, pl. xviii, figs. 2–4.—Ludw., Palæont., viii, p. 106, pl. xxxviii, figs. 9–11; pl. xxxix, lx, figs. 3–5, fruits.
Planera dubia, Lesqx., Am. Journ. Sci. and Arts, vol. xxvii, p. 361.
Planera longifolia?, Lesqx., Ment. Annual Report, 1873, p. 413.
Zelkova Ungeri, Kovats in Ung., Iconog., p. 42, pl. xx, fig. 19.—Massal., Syn. Fl. Foss. Senog., p. 43.
Ulmus zelkovæfolia, Ung., Chlor. Protog., pl. xiv, figs. 7–12.
Ulmus prælonga, Ung., Gen. et Sp., p. 411; Iconog., p. 43, pl. xx, fig. 20.
Ulmus parvifolia, Ung., Iconog., pl. xx, figs. 21 22.
Comptonia ulmifolia, Ung., Foss. Fl. v. Sotzka, p. 32, pl. viii, figs. 4, 5.
Fagus atlantica, Ung., Chlor. Protog., p. 105, pl. xxviii, fig. 2.
Quercus subrobur, Goepp., Tert. Fl. v. Schoss., pl. vii, figs. 8, 9.
Quercus semi-elliptica, Goepp., *loc. cit.*, pl. vi, fig. 4.
Quercus orcadum, Web., Palæont., ii, p. 172, pl. xviii, fig. 13.
Castanea atavia, Goepp., *loc. cit.*, p. 18, pl. v, figs. 12, 13.

Leaves short-petioled, ovate-acuminate, generally unequal at the base, simply dentate or crenate; secondary veins simple or branching near the point, curving upward in entering the teeth.

The leaf (fig. 7) was mentioned as referable to the former species from a sketch communicated by my friend, Capt. Berthoud. Receiving later from Dr. Hayden a specimen similar to the figure formerly sent, I had opportunity to compare it to those of *P. longifolia*, and to positively recognize the marked difference in the acute point of the teeth, the nervation, and the general form. I have also examined, as points of comparison, the figures of all the works quoted by Schimper in the above nomenclature, and in none of these do I find any leaf comparable in the characters to those of *P. longifolia*. We have therefore two species, *P. Ungeri*, described already from the Miocene of Alaska by Heer, and the former, exclusively referable until now to the Upper Miocene of Elko and the Parks.

HABITAT.—Castello's Ranch, Colorado (*Capt. Berthoud, Dr. F. V. Hayden*). Very rare.

CELTIDEÆ.

CELTIS, Tournf.

Considering its American representatives, this genus is distinctly characterized by petioled leaves, short, truncate or subcordate at the more or less inequilateral base, ovate or oblong-lanceolate, acuminate, with serrate, crenate, or entire borders, triple-nerved. The two lateral basilar nerves ascending to the middle of the leaves or above, are camptodrome, like their division and the secondary nerves also.

More than seventy species of this genus are described in De Candolle's Prodromus as distributed over the whole world. The number, however, is exaggerated; for the forms are disposed to vary greatly by culture and to be modified by various atmospheric changes. For example, twelve species are credited to North America, and these, from the opinions of botanists of the present time, who have had opportunity to compare them and to follow their variations, are reduced to two species, one, *C. occidentalis*, which ranges in longitude from the Atlantic to the base of the Rocky Mountains, and in latitude from New England to Florida, and the other, *C. pallida*, Torr., which inhabits Texas and Mexico. The first of these species is locally very abundant.

The geological records of *Celtis* are for this continent as yet obscure. The flora of the Mississippi Eocene has two fragments of leaves, described as *Celtis brevifolia*, Lesqx. (Trans. Am. Philos. Soc., vol. xiii, p. 416, pl. xx, figs. 4 and 5). The lower part of these leaves and their nervation show the characters of *Celtis;* but the upper part is destroyed, and thus the generic relation is not positively ascertained. In Europe, which has one living species only in its flora, paleontology has recognized seven species of *Celtis*, all Miocene.

MOREÆ.

FICUS, Tournf.

The leaves of species of *Ficus* are so variable in size, shape, consistence, nervation, etc., that it is not possible to expose any characters by which their reference to the genus may be positively ascertained. Schimper remarks on this subject (Pal. Végét., ii, p. 728):—"That most of our determinations of

Ficus leaves merely rest upon more or less evident probabilities, as the largest number of the fossil leaves referred to this genus could be ascribed to others by the same reasons which induced the authors to admit them as *Ficus*. And it is probable that the number of nearly one hundred fossil species now described will be considerably reduced when they have been thoroughly studied." In this memoir, the reference of the tertiary leaves to *Ficus* is essentially based upon their identity, or close relation of characters, to species described by European authors, who have access for their comparison to large collections from the whole world, while I have at my disposal only specimens from Cuba, Florida, and South America, which, though referable to numerous species, do not represent, by far, all the types of leaves pertaining to this genus.

The species of *Ficus* are extensively distributed between the tropics, in the humid and warm regions of the equator especially. Many are found in the West Indian Islands, in Jamaica and Cuba; three are indigenous in Florida. A single one inhabits the southern regions of Europe.

As far as evidence can be credited, the origin of the genus is Cretaceous both in Europe and America. Prof. Heer has two species from Moletin, one from Greenland, and one from the Dakota group. Three others are described from this same formation in Dr. F. V. Hayden's Annual Report, 1874, pp. 341 and 342, and four from Niedershoena by d'Ettingshausen. From the Eocene floras of both continents, numerous leaves are referred to *Ficus*, and the number greatly increases in Europe with the Miocene formation. In the Lignitic of the Rocky Mountains, *Ficus* leaves are most abundant in connection with remains of Palms in the Lower Eocene of Black Buttes, Golden, and the Raton Mountains; they are thus typical evidence of the temperature of the epoch.

§ I.—*Penninerved leaves.*

Ficus lanceolata, Heer.

Plate XXVIII, Figs. 1–5.

Ficus lanceolata, Heer, Fl. Tert. Helv., ii, p. 62, pl. lxxxi, figs. 2–5; iii, p. 182, pl. cli, figs. 34, 35; clii, fig. 13.—Mass., Fl. Senog., p. 223, pl. xxx, fig. 8.—Ett., Fl. Foss. v. Bil., p. 67, pl. xx, figs. 3, 4.—Heer, Mioc. Balt. Fl., p. 73, pl. xxii, figs. 1, 2.—Sism., Mater., pl. xv, fig. 5; xxvi, fig. 2.—Lesqx., Annual Report, 1871, p. 300; 1873, p. 414.

Leaves coriaceous or subcoriaceous, entire, lanceolate, tapering upward to a long acumen, and narrowed downward to a thick short petiole; midrib strong; lateral veins irregular in distance, camptodrome.

The leaves of this species are generally larger than those which are fig-

ured in our plate; the essential characters, however, the lanceolote form, the long tapering base, the thick petiole, and the nervation, are distinctly recognized upon the specimens. The substance is thick, rather coriaceous; the distance between the lateral nerves variable, and the areolation of the same type as in fig. 1, pl. xxii, of the Mioc. Balt. Flora, a leaf of the same size as those of our plate, whose fig. 3 compares also in every point to fig. 13, pl. clii, of the Fl. Tert. Helvet. Our fig. 5, however, does not closely agree in its characters with those of this species. The secondary nerves are too close and equidistant, reaching to near the borders, and following them in a series of curves. Its thick midrib refers it to a *Ficus*, and its narrowed base to this species. It is from a different locality, and the only fragment which I had for identification.

HABITAT.—The leaves in figs. 1–3 are from the Green River group, Wyoming, with *Populus arctica* and *Cyperus Chavanensis* (*Dr. F. V. Hayden*); fig. 4 is from a specimen from Willow Creek, Middle Park, Colorado (*Dr. W. H. Holmes*); and fig. 5 from Florissant, near South Park, Colorado (*Prof. E. D. Cope*).

Ficus Jynx, Ung.

Plate XXVIII, Fig. 6.

Ficus Jynx, Ung., Fl. v. Sotzka, p. 165, pl. xxxiii, fig. 3.—Ett., Tert. Fl. v. Här., p. 41, pl. x, figs. 6–8; Foss. Fl. v. Bil., p. 69, pl. xx, figs. 2–7.—Heer, Fl. Tert. Helv., ii, p. 63, pl. lxxxv, figs. 8–11.—Lesqx., Annual Report, 1873, p. 414.
Rhamnus Eridani, Ung., Foss. Fl. v. Sotzka., p. 178, pl. lii, figs. 4–6 (*fide* Ett.).

Leaves coriaceous, lanceolate, narrowed to the petiole; secondary nerves at an open angle of divergence, close, parallel, simple, straight to the borders, where they abruptly curve along them.

The leaves of this species, as represented by Heer and Unger (*loc. cit.*), are larger than the fragment figured here, and generally broadly oval and obtuse. Fig. 7, however, of the Bilin Flora is similar to ours in every point. The German author refers to this same species three leaves of the Sotzka Flora (figs. 4–6, pl. lii), which also closely resemble ours, especially fig. 6. The identity, however, is not absolutely ascertained on account of the fragmentary state of our leaf, whose petiole is broken and its upper part destroyed. The direction of the secondary veins, at the same angle of divergence as in the European form, and abruptly curving in touching the apparently reflexed borders, relate this leaf rather to *Rhamnus* than to *Ficus*.

HABITAT.—Elko Station, Nevada (*Prof. E. D. Cope*).

Ficus multinervis, Heer.

Plate XXVIII, Figs. 7, 8.

Ficus multinervis, Heer, Fl. Tert. Helv., ii, p. 63, pl. lxxxi, figs. 6–10; lxxxii, fig. 1.—Ett., Foss. Fl. v. Bil., p. 68, pl. xx, figs. 5, 6.—Lesqx., Annual Report, 1871, p. 300.

Leaves coriaceous, very entire, elliptical-lanceolate, acuminate, gradually or rapidly narrowed to the base; lateral nerves at an open angle of divergence, very close, parallel, curving close to the borders; areolation very small, quadrangular.

Considering the form of the leaves of this species, we see it represented in both figs. 7 and 8 of our plate, in coincidence, the first with figs. 7 and 8 of Heer (*loc. cit.*), and the second with fig. 6, which represents a leaf of about the same size, with the base round-truncate. Except that the secondary nerves are somewhat more oblique to the midrib, generally at least, but not more so than in fig. 7 (*loc. cit.*), the nervation has the same characters. The secondary nerves, very close, running straight to the borders, are separated by intermediate tertiary veins, which, though somewhat thinner, are quite discernible even to near the borders. Joined by nervilles in right angle, divided and subdivided in the same manner, the result is an ultimate areolation of very small and quadrangular meshes. This areolation, more distinct upon the American leaves than upon those described by European authors under this name, and also the more oblique divergence of the veins, seem, however, to disagree with the characters of the species, even with those of the genus. Considering these differences, Count Saporta is disposed to refer these leaves to *Laurus*, or perhaps to *Nerium*, rather than to *Ficus*.

Habitat.—Green River group, with the leaves represented in figs. 1–3 as *Ficus lanceolata* (*Dr. F. V. Hayden*).

Ficus oblanceolata, Lesqx.

Plate XXVIII, Figs. 9–12.

Ficus oblanceolata, Lesqx., Annual Report, 1872, p. 387.—Schp., Pal. Végét., iii, p. 595.

Leaves subcoriaceous, entire, obovate or oblanceolate, obtusely pointed or acuminate, cuneate to the petiole; secondary veins numerous, parallel, camptodrome.

The leaves of this species have some likeness to those of *F. lanceolata*, Heer. Their form is comparatively shorter and broader, and their nervation far more equal, the lateral nerves being close, equidistant, all upon the same angle of divergence of 50°, slightly curved in passing toward the borders and following them in double festoons. The basilar vein only, as seen in fig. 11, is sometimes more oblique. The nerves are deeply cut into the laminæ, though not very thick, and the surface is therefore undulate. The nervilles, in right angle to the secondary nerves and quite distinct, give

to these leaves a facies different from that of leaves of this genus. This character, as also the absence of tertiary intermediate veins, are, however, remarked upon the leaves of *Ficus elastica* and other living species, and in a less distinct degree upon those of the fossil *F. Gœpperti*, Ett. Nevertheless, I do not consider the relation of these leaves to this genus as positively ascertained

HABITAT.—Carbon Station, Wyoming.

Ficus arenacea, Lesqx.

Plate XXIX, Figs. 1–5.

Ficus arenacea, Lesqx , Annual Report, 1871, p. 300.

Var. *a*, brevipetiolata.

Figs. 2, 5.

Ficus Gaudini, Lesqx., Annual Report, 1871, p. 300.

Leaves large, coriaceous, very entire, broadly lanceolate, acuminate, rounded and narrowed to a thick petiole; lateral veins thick, subequidistant, parallel, camptodrome.

Though there is a marked difference in the size of these leaves, especially in the length of the petiole, they are so similar in shape, general facies, and nervation that they appear to represent the same species. In fig. 1, the base of the leaves is not rounded to the petiole, rather slightly decurrent, and, according to this form, the basilar lateral veins are more oblique than those of figs. 2 and 5. But the fragment on the right of fig. 1 has its base somewhat more enlarged and the basilar lateral nerves a little more open than those of the other leaves upon the same specimen, a deviation of type which becomes more marked when the base is more enlarged. The petiole of these narrower leaves is longer, a difference also seen sometimes upon leaves of *Ficus* of the same species. Except this, the characters are the same, consistence of the derma, thickness of the midrib, generally channeled, especially toward the base, direction and distribution of the secondary nerves, etc. In fig. 2, whose surface is more distinctly preserved, the veins are seen obliquely crossed by nervilles; but the details of areolation are obsolete. The size of the leaves varies from eight to fifteen centimeters in length and from three to eight centimeters in width.

HABITAT.—Green River group (*Dr. F. V. Hayden*).

Ficus Ungeri, Lesqx.

Plate XXX, Fig. 3.

Ficus Ungeri, Lesqx., Supplement to Annual Report, 1871, p. 7.

Leaf large, coriaceous, oblong, lingulate, acuminate or pointed, rounded to the base; borders very entire; lateral nerves open, equidistant, parallel, simply camptodrome.

This splendid leaf, twenty centimeters long without the petiole, ten centimeters broad, shows in its nervation the characters of species of this

genus, like that of *Ficus ferruginea*, for example, as it is represented, by impression of a living specimen, in Ett., Bil. Fl., pl. xix, figs. 3 and 4. The lateral nerves, on an open angle of divergence of nearly 70°, gradually curve upward in coming near to the borders, and follow them in simple festoons, anastomosing by nervilles. The nervilles, somewhat strong and in right angle to the midrib, are oblique to the secondary veins, generally branch in right angle also in the middle of the areas, and subdivide in the same direction, composing an ultimate, very small, irregularly quadrate areolation. Though the base is destroyed, its rounded form is surmised from the direction of the lower line of the fragment; and, by what is left of the border toward the point, it appears to have been acuminate. The leaf is runcinate on the surface. It does not compare to any fossil species, as far as I know at least. The middle nerve, though somewhat strong and deeply impressed into the stone, is not as thick by far as in the former species, to which it has, however, a certain degree of relation, especially to figs. 2 and 3, pl. xxix. It is remarkable that so many leaves of the same type are found together.

HABITAT.—Same as the former (*Dr. F. V. Hayden*).

Ficus irregularis, Lesqx.

Plate XXXIV, Figs. 4-7; LXIII, Fig. 9.

Ulmus? irregularis, Lesqx., Annual Report, 1872, p. 378.

Leaves large, coriaceous, very entire, broadly ovate or oval, constricted upward to an acumen, rounded or cuneiform to the inflated petiole; middle nerve narrow; lateral veins thin, in an acute angle of divergence, simply camptodrome, irregularly forking.

The secondary veins of this species are close, sixteen pairs in a leaf, part of which only, eight centimeters long, is preserved, averaging 40° in their angle of divergence from the middle nerve, curving slightly downward at their point of insertion, generally simple; some of them only abnormally forking from near the base, and joined by thin, numerous, somewhat oblique fibrillæ. The specimens which I had for my first examination (figs. 4 and 5) have the borders destroyed, and I was therefore very uncertain to what genus these leaves should be referred, their nervation being analogous to that of *Ulmus*, especially in the peculiar forking of some of the lateral nerves The specimens (figs. 6 and 7) found later contradict this reference. The borders perfectly entire, the simply camptodrome nervation, are characters at variance with those of *Ulmus*. On the other hand, the close, numerous, parallel, and equidistant camptodrome secondary nerves are remarked in species of *Ficus*, in *F. Jynx*, *F. multinervis*, for example, and the enlarged petiole,

pl. xxiv, fig. 4, and pl. lxiii, fig. 9, as also the close, oblique nervilles, are proper to this genus. The reference of these leaves to *Ficus*, or to a genus of the same family, seems confirmed by their affinity to *Artocarpoides pouroumæformis*, Sap. (Fl. Foss. de Séz., p. 357, pl. vi, fig. 7), which they closely resemble, and which was formerly described as a *Carpinus* by Watelet on account of its peculiar nervation.

HABITAT.—Golden, Colorado.

Ficus uncata, Lesqx.

Plate XXXV, Figs. 1, 1 *a*, 2.

Ficus ulmifolia, Lesqx., Annual Report, 1871, Supplement, p. 14.

Leaves large, coriaceous, very entire, broadly ovate, obtuse, rounded, and declining at the base to a thick hooked petiole; middle nerve thick, channeled; lateral nerves close, parallel, camptodrome.

These leaves evidently pertain to a different species, though having some of the characters of the former. The middle nerve is, at least, twice as thick, as also the more distant lateral ones; the petiole, equally much stronger, is shorter and hooked, and the leaves as seen in fig. 1 are obtuse. The nervilles, though stronger, are slightly oblique to the secondary nerves, and of the same type as in the former species. The specimen in 1 *a* is from a different locality, but by the form of the leaf and its very thick nerve it seems referable to this species. Its relation to fossil congeners is apparently to the *Protoficus* of the Eocene of Sézanne, like *P. insignis*, Sap. It has a more distant affinity to *Ficus? borealis*, Heer, of the Baltic Miocene Flora.

HABITAT.—Carbon, Wyoming; the specimens of figs. 1 and 2. I found these two specimens only in the shale above the main coal. The fragment of fig. 3 is from the Raton Mountains, New Mexico, in shale intermediate to the lower beds of lignite (*Dr. F. V. Hayden*). There are some other fragments of the same locality, all representing merely the basilar part of the leaves. I have recently received a fine specimen of this species, sent by *Mr. Geo. Hadden*, from Coal Creek, Colorado.

The name *Ficus ulmifolia* is necessarily changed, being preoccupied.

Ficus Haydenii, Lesqx.

Plate XXX, Fig. 1.

Ficus Haydenii, Lesqx., Annual Report, 1872, p. 394.—Schp., Pal. Végét., iii, p. 595.

Leaves subcoriaceous, entire, enlarged downward, rounded and truncate to a long petiole, tapering upward to a long, twisted acumen; secondary nerves thin, curved in passing to the borders, camptodrome.

This leaf seems referable to *Ficus* on account of its long twisted point, which, like the general form, is related to *F. appendiculata*, Heer (Fl. Tert.

Helv., p. 67, pl. lxxxv, figs. 12 and 13). The nervation is, however, of a different type, rather like that of the two former species. By its shape, the leaf resembles a *Populus*. Its base, enlarged after curving slightly down to the petiole, is rounded, and the upper part is lanceolate at first and then contracted into a long twisted acumen. The midrib is of medium thickness, as is the petiole also, which is apparently broken, and therefore comparatively long; the secondary nerves, alternate, subequidistant, slightly deflecting to the midrib, pass in broad curves under an angle of 40° to 50° to the borders, which they follow, anastomosing in simple bows; the nervilles are strong, of the same disposition as in the former species. The only specimen obtained of this is figured. The lamina of the leaf is seven and a half centimeters long with the acumen, five centimeters broad below the middle, and the petiole two and a half centimeters.

HABITAT.—Black Buttes, Wyoming; very rare.

Ficus ovalis, Lesqx.

Plate XXX, Fig. 2.

Ficus ovalis, Lesqx., Annual Report, 1874, p. 313.

Leaf coriaceous, oval, entire, narrowing in a curve to a long, thick, flat, grooved petiole; lateral nerves alternate, camptodrome; tertiary veins short; areolation obsolete.

I have seen of this species only the specimen figured here. The leaf, whose upper part is destroyed, seems to be gradually narrowed to an obtuse point. It is six to seven centimeters long, the preserved part being four and a half centimeters; four centimeters broad, and the petiole three centimeters. The borders at the base are abruptly bent down to the petiole, and follow it, forming a flat margin on both sides. The lateral veins are all on the same broad angle of divergence of about 60°, the lowest joining the midrib a little above the base, with indistinct basilar veinlets, whose fragments are seen on the left side of the figure. They anastomose in simple curve in following close to the borders. The nervilles and areolation are obsolete; some veinlets, probably branches of the secondary veins, are distinct in the upper part of the fragment. No species of fossil *Ficus* is distinctly related to this; the form of the leaf resembles that of *Populus mutabilis* var. *ovalis*, Heer.

HABITAT.—Pleasant Park, Plum Creek, Colorado, with *Sabal Goldiana* (*Dr. F. V. Hayden*).

Ficus dalmatica, Ett.

Plate LXIII, Figs. 3–5.

Ficus dalmatica, Ett., Eoc. Fl. d. M. Prom., p. 13, pl. vii, fig. 11.—Lesqx., Annual Report, 1874, p. 303.

Leaves subcoriaceous, entire, narrowly ovate-lanceolate, obtusely acuminate, narrowed in a curve to a short, thick petiole; midrib thick, especially toward the base; basilar lateral nerves at a more acute angle of divergence than the upper ones, ascending to the middle of the leaves; secondary nerves camptodrome, joined by transverse oblique nervilles.

As seen in fig. 3, the leaves are attached to the stem by a short petiole, which in fig. 4 appears inflated by the decurrent border of the leaves. The lower lateral nerves, joining the midrib a little above the border base under an angle of divergence of about 30°, are inequidistant from the upper ones, which are more open, parallel, and curving along the borders, anastomosing in simple bows and united by distinct veinlets more or less oblique to the veins. The base of fig. 5 is not seen, and is represented truncate, an appearance caused by its reversement into the stone, the upper part of the leaf being flattened upon the specimen and the lower curved back or forced down into the imbedding matter. All the leaves are small, varying from three and a half to five and a half centimeters long without the short petiole, and one and a half to nearly two centimeters broad below the middle. Though the species from Promina is represented by a single leaf, its general form, the characters of the nervation, the basilar decurrent part enlarging the petiole, a part evidently destroyed in the European specimen, are so distinctly alike that I do not find any reason for doubting identity; even the slightly obtuse points of the leaves inclining to one side are exactly similar in both fig. 11 of Promina and fig. 4 of our plate.

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden, Wm. Cleburn*).

Ficus spectabilis, Lesqx.

Plate XXXIII, Figs. 4, 5, 6.

Ficus spectabilis, Lesqx., Annual Report, 1872, p. 379.—Schp., Pal. Végét., iii, p. 595.

Leaves variable in size, mostly large, coriaceous, entire, broadly ovate, lanceolate, acuminate, rounded to the petiole; nervation distinct, camptodrome.

The first description of this fine species was made from fig. 5, one of the largest leaves, by which it is represented until now. It is fifteen centimeters long, eight centimeters broad below the middle, where it is the widest, with the point broken, as it is also in all the other specimens obtained later. The lowest pair of basilar nerves are opposite, sometimes slightly stronger, as in fig. 5, but sometimes also passing to mere marginal simple veins, becom-

ing thinner or nearly effaced, as in fig. 4. All the divisions are camptodrome, the lateral nerves passing at an angle of 40 to 50°, nearly straight toward the borders, where they abruptly curve, anastomosing in simple bows; the nervilles, oblique to the secondary veins, are strong, either simple or more rarely divided in the middle; the details of areolation are obsolete. Though the surface of these leaves is cut by the deeply impressed nervation, it is smooth, nearly polished.

HABITAT.—Golden, Colorado.

Ficus? Smithsoniana, Lesqx.

Plate XXXII, Fig. 5.

Juglans Smithsoniana, Lesqx., Supplement to Annual Report, 1871, p. 16.

Leaf coriaceous, smooth, lanceolate, gradually tapering upward from above the base, and acuminate; borders entire and undulate; middle nerve flat and broad; lower pair of lateral veins more oblique and ascending higher; nervation camptodrome.

This fine leaf, rounded and narrowed to the base, has slightly unequal borders, the secondary veins irregular in distance, and nervilles in right angle to the midrib and oblique to the lateral nerves. Of its characters, none is clear enough for a definition of its generic relation. It has a degree of likeness by its form to *Ficus Falconeri*, Heer (Foss. Fl. of Bovey Tracy, Phil. Trans., 1862, p. 1060), especially like fig. 7 of pl. lxiv. The leaves of the English species are, however, more narrowly attenuated to the base. I considered it at first as a *Juglans*, but the coriaceous leaves are against this reference. Count Saporta supposes that it may represent an *Aralia*.

HABITAT.—Raton Mountains, New Mexico (*Dr. F. V. Hayden*).

§ II.—*Palmately-nerved leaves.*

Ficus occidentalis, Lesqx.

Plate XXXII, Fig. 4.

Dombeyopsis occidentalis, Lesqx., Annual Report, 1872, p. 380.—Schp., Pal. Végét., iii, p. 607.

Leaves comparatively thick, coriaceous, truncato-cordate at the base, narrowed upward into an obtuse acumen, palmately triple-nerved; lateral veins equidistant, parallel, camptodrome.

A number of finely preserved specimens of this species have been obtained from the same locality, all, however, deprived of the petiole. Their characters, form and nervation, as well as the coarse surface of the leaves, deeply furrowed by the nerves, relate them to the following species. The leaves are all of the same large size, twelve centimeters long or more, about

ten centimeters broad toward the base, where they are enlarged, rounded, and subcordate, contracted upward to a short, obtuse acumen. The lateral veins, all thick, on the same angle of divergence, are nearly equidistant, the basilar pair, much branched on the lower side, being not more distant from the first pair of secondary veins than these are between themselves. The areolation is irregularly quadrate or polygonal, formed by subdivisions in right angle from deep nervilles, joined in the middle, rarely simple. From the comparison of the characters of these leaves with those of the following species, I have been induced to refer them to the same genus. *Dombeyopsis* as a genus is still uncertainly limited. A number of the species described under this name are now distributed in other genera, *Grewiopsis*, *Grewia*, and *Ficus*, especially, as seen from the synonymy of *F. tiliæfolia*, a form to which our species is also related.

HABITAT.—Golden, Colorado; not frequent.

Ficus planicostata, Lesqx.

Plate XXXI, Figs. 1–8, 10, 11, 12.

Ficus planicostata, Lesqx., Annual Report, 1872, p. 393.—Schp., Pal. Végét., iii, p. 594.

Leaves of medium size, subcoriaceous, entire, elliptical or broadly oval, slightly acuminate or obtuse, rounded to a short, thick petiole, palmately three-nerved from the top of the petiole, rarely from a short distance above the base; primary and secondary nerves broad, flat, all camptodrome, as well as their divisions.

The essential character of these leaves, extremely abundant at Black Buttes, found also at Golden and other localities, is the broad, flattened face of the nerves. Their surface is not as coarse, their consistence not as thick as in the former species, and all the leaves have the same graceful oval shape. The basilar nerves are generally at a greater distance from the secondary ones; the characters of the nervation and the areolation, however, being the same. All the nerves are more or less branching, the primary ones from the base to the point, the secondary ones only toward the borders, where all the divisions abruptly curve quite near the margin, sometimes passing into the edges. The leaves are of medium size. The largest which I have seen is twelve centimeters long and seven centimeters broad in the middle. As seen in figs. 2, 4, and 10, the top is sometimes abruptly contracted into a short acumen; they are, however, more generally obtuse. The species seems very variable. I am, however, uncertain if the forms described here as varieties do not represent separate species. Fig. 6 is a branch with unfolding leaves.

HABITAT.—Black Buttes, Wyoming, there very abundant; Golden, Col-

orado, rare; Point of Rocks (*Dr. F. V. Hayden*). *Mr. Geo. Hadden* recently sent a specimen of the same character and size as that of fig. 3 from Coal Creek, Colorado.

Ficus planicostata, var. **latifolia**, Lesqx.

Plate XXXI, Fig. 9.

Ficus planicostata, var. *latifolia*, Lesqx., Annual Report, 1872, p. 393.

Leaves large, subcoriaceous, broadly round, subcordate; nervation same as the former.

This variety merely differs in the larger size and the broadly round form of the leaves, whose base is slightly cordate. I have found only two leaves with these characters; they do not seem distinct enough to authorize a separate specification, though the numerous specimens representing the normal form do not deviate in any way from it. The specimen as seen in fig. 9 *a* bears at the corner a small fruit, nearly round, narrowed to a short, broad pedicel, with its surface wrinkled, comparable to the fruits of some of the present species of *Ficus* of Cuba, like *F. dimidiata*, for example. I found another at the same locality upon a piece of soft shale, unhappily crushed in the transportation of the specimens; its size was like that of a small walnut, and its shape and appearance like that of the one figured here.

HABITAT.—Golden, Colorado, and Black Buttes, Wyoming.

Ficus planicostata, var. **Goldiana**, Lesqx.

Plate XXXIII, Figs. 1, 1 *a*, 2, 3.

Ficus planicostata, var. *Goldiana*, Lesqx., Annual Report, 1873, p. 399.
Ficus Clintoni, Lesqx., Annual Report, 1872, p. 393.

Leaves large, oval, contracted upward into a short acumen, round-cuneate to the base, primary and secondary nerves thin.

It may be that the leaves of pl. xxxi, figs. 7, 8, 11, 12, which I consider as mere young, undeveloped representatives of the normal form, are referable to this so-called variety, for they evidently differ, by their narrow veins and thin substance, from the small, still unopened leaves of fig. 6 of the same plate, which has the principal nerves as broad and flat as in fig. 1. They have, however, the obtuse point, and have been found all mixed with the others at Black Buttes. Fig. 10 of pl. xxxi also is related to this variety by its top, contracted into an acumen, but here we have flat nerves, and the leaf has been found at Golden. These three leaves of pl. xxxiii are larger, somewhat more distinctly narrowed to the base, the veins curving still closer to the borders, which they seem to enter. They appear also narrowed upward

to a point, a character which is not, however, ascertained, the point of all the specimens being destroyed. Nor can I take into consideration the petiole, of which I find no fragment. Hence, though great the affinity appears to be, these leaves may represent another species, even be referable to another genus. The Flora of Sézanne has, under the name of *Sterculia variabilis*, Sap. (p. 400, pl. xii, figs. 6 and 7), two leaves which resemble those figured here by the shape and the principal nervation. They differ, however, by the distribution of the lateral veins, which do not reach close to the borders, but follow them in double festoons.

HABITAT.—Golden, Colorado.

Ficus tiliæfolia, Al. Br.

Plate XXXII, Figs. 1, 2, 2 *a*, 3; Plate LXIII, Fig. 8.

Ficus tiliæfolia, Heer, Fl. Tert. Helv., ii, p. 68, pl. lxxxiii, figs. 3–12; lxxxiv, figs. 1–6; lxxxv, fig. 14; iii, p. 133, pl. cxlii, fig. 25; clii, fig. 14.—Ung., Sillog., i, p. 14, pl. vi, fig. 2.—Sism., Mater., p. 436, pl. xvii, fig. 5.—Ett., Foss. Fl. v. Bil., p. 80, pl. xxv, figs. 4, 5, 10 (?).—Heer, Mioc. Balt., Fl., p. 74, pl. xxi, fig. 12.—Gaud. & Strozzi, Feuilles Foss., p. 34, pl. xii, fig. 11.—Schp., Pal. Végét., ii, p. 746.—Lesqx., Annual Report, 1871, pp. 287, 298, 299; Supplement, pp. 12, 16; Annual Reports, 1872, pp. 375, 393; 1873, p. 399; 1874, p. 304.
Tilia mutabilis, Goepp., Palæont., ii, pl. xxxvii, fig. 1.
Tilia prisca, Al. Br. in Ung., Synops., p. 234.
Cordia? tiliæfolia, Al. Br. in Bronn., Jahrb., 1845, p. 170.
Acer Beckerianum, Goepp., Palæont., ii, p. 279, pl. xxxvii, fig. 2 *c*.
Dombeyopsis tiliæfolia, Ung., Gen. et Sp., p. 447; Foss. Fl. v. Sotzka, p. 45, pl. xxv, figs. 1–5.—Goepp., *loc. cit.*, pl. xxxvi, fig. 3 (?).
Dombeyopsis grandifolia, Ung., Gen. et Sp., p. 447; Foss. Fl. v. Sotzka, pl. xxvi, figs. 1, 2.—Goepp., *loc. cit.*, p. 22, pl. v, fig. 2 *b*.
Dombeyopsis sidæfolia, Ung., Gen. et Sp., p. 448.
Dombeyopsis lobata?, Ung., *loc. cit.*, p. 447.
Dombeyopsis æqualifolia?, Goepp., Palæont., p. 278, pl. xxxvi, fig. 4, xxxvii, fig. 2 *a*.—Lesqx., Supplement to Annual Report, 1871, p. 10.

Leaves of various sizes, generally very large, coriaceous, entire, broadly oval or nearly round, slightly abruptly pointed, more or less inequilateral and cordate at the base; nervation thick, coarse, camptodrome.

The species described under so many different names in most of the European Tertiary floras is as widely represented in the Tertiary formations of North America, and also as very variable, if not in its characters, at least in the size of the leaves, as it is in Europe. Most of the specimens representing it from the Lower Lignitic of the Rocky Mountains are fragments of very large leaves, like those figured in our plates, none of them being found in the whole.* In

* I have lately received, by a communication from Mr. George Hadden, from Coal Creek, Colorado, a fine specimen of this species, representing a whole leaf, except the mere point. It is more than fourteen centimeters long, eleven centimeters broad, cordate and inequilateral at the base, with a short, thick petiole, enlarging downward, two and a half millimeters thick at the base of the leaf, and four millimeters at the point where it is broken two centimeters below its point of attachment. It has all the characters of the species: form of leaf nearly round, nervation, rough surface, etc.

the Pliocene of California, this species is, per contra, represented by small leaves, which preserved in full show distinctly their inequilateral base, a peculiar character of this species. I have no doubt, however, on the identity of the American form, as represented in large leaves, with that of Europe. Figs. 1 and 2 of pl. xxxii, and also fig. 8 of pl lxiii, exactly correspond with the two fragments figured by Heer (Fl. Tert. Helv., pl. cxlii, fig. 25), while fig. 3 of pl. xxxii, though somewhat deformed, is like a representative of pl. lxxxiii, figs. 4 and 10, of the same author. Besides the inequality of the side of the leaves, the species has, for its more general characters, the coarseness of its surface, roughened by the impression of its deep, thick nerves, all camptodrome as well as their divisions, and curving quite near the borders, even bordering them in their abrupt curves, as in the former species. This character is especially definite upon our fig. 3, which I was at first inclined to consider as belonging to a different species. *Ficus planicostata* is very closely related to this; but it has not been found with inequilateral leaves, and its general appearance is different. It is, however, of the same type.

HABITAT.—Washakie Station, Wyoming; six miles above Spring Canon, near Fort Ellis, Montana; near Yellowstone Lake, Wyoming, among basaltic rocks; Point of Rocks Station, Wyoming; Evanston, Wyoming, above coal; Fischer's Peak, Raton Mountains, New Mexico (*Dr. F. V. Hayden*). Sand Creek, Colorado (*Dr. A. B. Marvine*). Found at the Gehrung Coal near Colorado City; also at Black Buttes, but rare; more common at Golden. Its distribution is, therefore, from the lowest stage of the Lignitic Eocene to the highest Tertiary measures, as it has been found in the Pliocene flora of the gold-bearing gravel of California. The basaltic rocks of Yellowstone Lake may correspond to this last station.

Ficus pseudo-populus, Lesqx.

Plate XXXIV, Figs. 1 *a*, 2.

Ficus pseudo-populus, Lesqx., Annual Report, 1874, p. 313.

Leaves of medium size, oval, pointed, or acuminate, entire, narrowed downward to a long petiole, palmately three-nerved from the base; lateral primary veins at an acute angle of divergence, ascending to above the middle; secondary veins, two or three pairs, parallel to the primary ones, but at a great distance above them; divisions all camptodrome.

This species is a remarkable one, resembling a *Cinnamomum* by its principal nervation, a *Zizyphus* by the form of the leaves, a *Populus* by its entire borders and long petiole, a *Ficus* by the areolation, as marked in fig. 2 *b*. It is allied to *F. Schimperi*, Lesqx. (Trans. Am. Phil. Soc., xiii, p. 418, pl. xviii,

figs 1–3), evidently differing, however, by its long petiole, and the position of the primary lateral nerves diverging from the top of the petiole at the base of the leaves. These are about all of the same size, eight to ten centimeters long, and three to four centimeters wide at the middle. The veins and nervilles are very distinct though thin, the nervilles nearly at right angle to the midrib, crossed by oblique branchlets, result into a large inequilateral or polygonal areolation.

HABITAT.—Evanston, Wyoming; Green River group (*Dr. F. V. Hayden*).

Ficus Wyomingiana, Lesqx.

Plate XXXIV, Fig. 3.

Ficus Wyomingiana, Lesqx., Annual Report, 1874, p. 314.

Leaves of the same form, size, and consistence as the former; primary lateral nerves acrodrome; secondary nerves none.

The fragment figured here has, by the outline of the leaf which it represents, a great likeness to those of the former species, differing merely, it seems, by the absence of secondary nerves, whose place is taken by strong nervilles, inflated toward the midrib. The primary lateral veins curve inside, and ascend apparently to the top of the leaf. The areolation is of the same character. It may be a mere variety.

HABITAT.—Green River group, with the former (*Dr. F. V. Hayden*).

Ficus subtruncata, Lesqx.

Plate XXX, Figs. 7-9.

Ficus truncata?, Heer, Lesqx., Annual Report, 1873, p. 400.

Leaves comparatively small, entire, truncato-cordate at the more or less inequilateral base, ovate or oblong, acuminate; borders undulate.

As far as the species is represented by the three leaves figured here, it seems truly different from Heer's species as described from one leaf only (Fl. Tert. Helv., iii, p. 183, pl. clii, fig. 15). The basilar or subbasilar veins are in the American form more numerous, two, even three, pairs, thin, more distinctly following the borders in simple curves, scarcely branching. The base of the leaves is rather subcordate than truncate, and from fig. 9 the top seems rather acuminate than obtusely pointed. Except the fragment in fig. 8, our specimens represent small leaves of a rather thick consistence, a character at variance also with that indicated by Heer, who describes his leaf as membranaceous. Notwithstanding these differences, both forms are closely allied. The areolation, as seen in fig. 7, is large and irregularly polygonal,

and the petiole in fig. 9 is enlarged toward the base, indicating the relation of these leaves to *Ficus.* The areolation seen upon the leaf of Heer is of the same type as that of our fig. 7, only smaller. In this fig. 7, the base is equilateral; fig. 9 shows it, on the contrary, distinctly inequilateral.

HABITAT.—All the specimens have been obtained at the same locality—Table Mountain, near Golden, Colorado, where they are mixed with *Sabal* leaves, *Platanus Haydenii*, etc.

Ficus auriculata, Lesqx

Plate XXX, Figs. 4–6.

Ficus auriculata, Lesqx., Annual Report, 1872, pp. 379, 406.—Schp., Pal. Végét., iii, p. 595.

Leaves rather coriaceous, entire, ovate-lanceolate, obtusely pointed or exactly ovate in shape, deeply cordate or broadly auriculate at the base; basilar nerves in three or four pairs; divisions camptodrome.

As seen in fig. 5, which represents the more general character of these leaves, three pairs of nerves come out from the base of the leaves at the top of the petiole, passing in curves to the borders of the auricles. In the small leaves (figs. 4 and 6), the same number of basilar veinlets are attached to the petiole, and in right angle to it, indicating the same character of nervation. It is, however, seen to be the same in fig. 7 of the former species, and it is possible that the fragments (figs. 4 and 6) should be referred to it; for, since the preparation of the plates, I have received, from other localities, a number of specimens, all representing leaves of about the same size as fig. 5, seven to nine centimeters long, five to seven centimeters broad, all deeply auricled at the base, and more evidently coriaceous than those of figs. 4 and 6, and those also of the former species. The nervation is coarse, of the same character as that of *Ficus planicostata*, but with the nerves half-round, the nervilles still thicker, closer, in right angle to the midrib, mostly simple, with smaller divisions coming out in right angle, forming large, square, primary meshes, whose subdivisions, somewhat obsolete, constitute very small, ultimate, round-polygonal areolæ. In well-preserved specimens, the point of attachment of the petiole is exactly round, five millimeters in diameter, thus indicating a comparatively thick petiole, and the palmately seven-divided nervation is clearly seen; for all the nerves around the petiole are thick, not quite as thick, however, as the upper primary ones. Most of the leaves are exactly ovate, and obtuse, rarely marked at the top by a very short, abrupt point. The leaves of this species, though resembling by their form those of some

species of *Aristolochia*, have distinctly the same essential characters as those of *F. planicostata* and *F. tiliæfolia*, and represent the same type. They appear to be as profusely distributed at some localities as *F. planicostata* is at Black Buttes.

HABITAT.—Six miles above Spring Cañon, Montana (*Dr. A. C. Peale*); lately obtained by the same geologist from north of Grand River, Colorado. It is not rare at Golden, Colorado, where the fine specimen of fig. 5 was found.

Ficus asarifolia, Ett.

Plate LXI, Figs. 18-21.

Ficus asarifolia, Ett., Foss. Fl. v. Bil., p. 80, pl. xxv, figs. 2, 3.—Schp., Pal. Végét., ii, p. 748.—Lesqx., Annual Report, 1872, p. 378; 1874, p. 303.

Leaves petioled, broadly reniform, subcordate or subpeltate, rounded upward; borders crenulate, primary nerves palmately five to seven, the middle ones straight, the upper lateral ones somewhat stronger than the lower, curving inward, branching and anastomosing with the branches of the middle nerve, which are few and distant from the base; veinlets thick, transversal, forming by subdivisions an embossed-like, very distinct, polygonal areolation.

Though this species has been already briefly described from specimens found at Golden, it has not before been figured, the first fragments obtained being all too incomplete. It is, however, recognized easily by its peculiar nervation, forming in its subdivisions small, elevated, polygonal areolæ, which give to the surface the appearance of a very small embossed check-board, like that of the leaves of *Asarum Europeum*. The meshes are mostly equilateral or nearly square along the borders, more or less and irregularly expanding outside, and thus forming crenulations more or less distinct, according to the size of the leaves. The fragments from Golden represent much larger leaves than those described in the Flora of Bilin. Those figured here, from specimens of Point of Rocks, are perfectly well and entirely preserved, and rather smaller than those of Europe. They are also slightly more enlarged on the sides, or reniform, and the crenulation is scarcely distinct. But the border divisions are, for their expansion, related to the areolation, which is proportionate in size to that of the leaves. The American leaves are evidently either peltate or auricled, as seen in three of the figured specimens. One only has the base and the attachment of the thick petiole marked similarly to that of the European leaves; but even the figures of the Bilin Flora seem to indicate peltate leaves, whose borders are erased at the base or at the point of attachment of the petiole. Fig. 21 of our plate also has a short, thick, flat petiole, only one centimeter long; but it is evidently broken. These differences are unimportant, and cannot be considered as specific characters. Our leaves,

varying in size from one to four centimeters broad and one to two and a half centimeters long only, merely represent a local variety, var. *minor*, while those of Golden may belong to the normal form. The species appears to be rare in the Tertiary of Europe, where it has been seen until now only in the plastic clay-beds of Bilin.

HABITAT.—Golden, Colorado, in fragments of large leaves; Point of Rocks, Wyoming, mixed with the floating plants, which are represented upon the same plate (lxi, figs. 1 to 17) (*Dr. F. V. Hayden, Wm. Cleburn*).

OLERACEÆ.

POLYGONEÆ.

COCCOLOBA, Jacq.

The leaves of this genus are generally broadly oval, coriaceous, rounded to a short petiole, all penninerved, with the divisions of the lateral veins irregular. The present species inhabit the tropical and subtropical regions, mostly of the American continent; some of them are found in Cuba, and two at least as far north as Florida. Two species only have been described as fossil, both in the Foss. Fl. of Bilin, by d'Ettingshausen, from the Middle Miocene.

Coccoloba lævigata, Lesqx.

Plate XXXV, Fig. 7.

Coccoloba lævigata, Lesqx., Annual Report, 1872, p. 387.

Leaves membranaceous or subcoriaceous, very entire, round, rather broader than long, apparently very obtuse, abruptly contracted at the base, and slightly decurring to the inflated midrib; surface smooth.

Two fragments only, and both alike, have been found of these leaves, which are nearly round, or broader than long, of a comparatively small size, four and a half centimeters across, with borders apparently reflexed, very entire, merely undulate. The midrib is enlarged and flattened from below the middle of the leaves downward; the lower lateral veins closer, irregular in distance and direction, on an open angle of divergence; the upper ones more oblique, or branching underneath, and anastomosing in double or triple bows to the borders. The nervation is irregular, like that of the leaves of some species of this genus, *C. floridana*, Meiss., for example, or one of its varieties, which was found in cultivation at Key West. Its leaves are smaller, some of them either gradually narrowed or abruptly contracted at the base, as in the fossil species, with the marginal veinlets either following the borders and normally anastomosing with branches of the secondary veins, or passing straight

up, cutting across the veins and dividing the areas, as it is seen on the right side of fig. 7. The veins are all very black, while the color of the leaves or of the prints upon the stones is yellow. The substance is somewhat thick, not positively coriaceous, but membranaceous. The inflated midrib is not observed upon any specimens of the living species which I had for comparison; it is, however, a character of some *Poligoneæ*, a family to which the *Crednericæ* of the Cretaceous were referred on that account.

HABITAT.—Carbon, Wyoming.

NYCTIAGINEÆ.

PISONIA, Plum.

A genus represented, like the former, by arborescent species distributed more generally in the tropical regions of the whole world. The leaves are generally oval or obovate, entire, of a hard consistence, with a strong midrib and delicate, distant, secondary veins. The flowers or fruits are persistent, corymbose, and cymose; these characters, rather than those of the leaves, are important for the evidence of generic identity. Four fossil species only have been described from the Tertiary of Europe. One only, *Pisonia Eocenica*, Ett., has been found with the leaves and the organs of fructification. Two living species inhabit Florida: *P. aculeata*, L., and *P. obtusata*, Swartz.

Pisonia racemosa, Lesqx.

Plate XXXV, Fig. 4.

Pisonia racemosa, Lesqx., Annual Report, 1873, p. 400.

Leaves small, membranaceous, entire, obovate, rounded, or very obtuse at the point, gradually narrowed downward to a flexuous thin petiole, triple-nerved at the base.

The only leaf which we have of this species is marked by four pairs of thin veins, parallel, inequidistant, in an acute angle of divergence of about 30°, curving quite near the borders; the areolation obsolete. The fruits, or unopened receptacles or buds, are in branched corymbs, or clusters, of six to eight, short-pediceled, either erect or horizontal or pending achenia (?), which are short, narrowly ovate, acute, rounded, or narrowed to the base, borne on filiform pedicels. This species is allied to *P. Eocenica*, Ett. (Fl. v. Här., p. 43, pl. xi, figs. 1–22), differing especially by its much shorter achenia, in more divided racemes. D'Ettingshausen compares the fruits (?) of his species to the

unfolded buds or the ovaries of species of this genus. In the American specimen, these ovaries appear like small involucres of ripe seeds, the tegumen being a thin, shelly envelope, and the inner substance transformed into coal, like a small nutlet, either entire or cut lengthwise in the middle, as seen in the enlarged fig. *c*. All the living species of this genus which I had opportunity to examine for comparison have the carpels linear and comparatively much longer.

HABITAT.—Black Buttes, Wyoming, in the shale of the burned bed; very rare.

PROTEINEÆ.

This family is represented at our time by a very large number of species, mostly distributed in the southern hemisphere, in the extratropical zones of Austral Africa, New Holland, and New Zealand. A few species inhabit the subtropical and tropical regions of the American continent.

The European paleontologists formerly referred to genera of this family many species which, most of them, have since been recognized as related to plants of countries whose flora and general natural history are analogous to those of the present time in the northern hemisphere. Thus, for example, the greatest number of species formerly referred to *Banksia* are now placed in the genus *Myrica*, and some of the most eminent botanists of our time, Bentham among others, assert that until now we have had no positive evidence of the presence of the *Proteeæ* in the fossil floras. It has been seen already that the leaves referred to *Proteeæ*, from specimens of the Cretaceous *Proteoides*, are of uncertain reference, and the presence in the American Tertiary of a single leaf, possibly referable to this family, seems to confirm the now more generally prevailing opinion that the analogy of leaves whose characters are not perfectly or sufficiently definite should be looked for in floras of the countries where the essential analogous vegetable and animal types are more generally found. Schimper observes, with reason, that neither the Cretaceous nor the Tertiary faunas of Europe have any analogy with those of Australia, and that therefore the plants should follow, and have probably followed, a distribution in harmony with that of the animals.

PROTEEÆ.

LOMATIA, Rob. Br.

Lomatia? microphylla, Lesqx.

Plate LXV, Figs. 14, 15.

Lomatia microphylla, Lesqx., Annual Report, 1874, p. 315.

Leaves very small, coriaceous, entire, linear-lanceolate, gradually narrowed from the middle to a point, and in the same degree to the base; secondary veins simple, abruptly curving near the borders and following them or entering a marginal band.

These very small leaves, two to four centimeters long, from two and a half to four millimeters broad, and of a thick substance, are very similar in shape, and also in the character of their nervation, to *Lomatia firma*, Heer (Balt. Fl., p. 35, pl. viii, figs. 6–9), the secondary veins being straight and on an open angle of divergence to the borders, where they abruptly curve, or rather enter a marginal vein. This last character is more evident than would be a curve, even abrupt, and therefore the reference to this genus might seem to be authorized, though this is as yet the only species of our Tertiary flora referable to this family. But there is also a marked resemblance of these leaves with the fine *Pistacia aquensis*, Sap. (Ét., iii, 2, p. 203, pl. xv. figs. 1–24), and this reference would be the more admissible, since species of the *Anacardiaceæ* are very abundant in the formation where these leaves have been found. As no trace of intermediate veins or of areolation can be observed on the specimens, I am unable to decide. The form of the leaves is more like that of the *Lomatia* as figured by Heer. Anyhow, this species is evidently different by the form and size of its leaves from both the European ones to which it is compared. In fig. 15 of our plate, the lateral veins are indiscernible, the thick epidermis, transformed into coal, covering them entirely, except near the border, where the marginal veinlet is indistinctly observable.

HABITAT.—Green River group, Wyoming, with *Sapindus obtusifolius* and *Musophyllum* (*Wm. Cleburn*).

LAURINEÆ.

This order of plants is now widely distributed in the tropical regions of Asia and of America; very few species living in Australia, and still fewer in Africa. A single species belongs to Europe. Of more than nine hundred species, referred to fifty-four genera, as described by Meissner in the Prodromus, we have, in the present flora of North America, five representatives only, of the genera *Persea*, *Sassafras*, *Benzoin*, and *Tetranthera;* South Florida has two more, one *Persea* and one *Cassytha;* California has two *Oreodaphne.*

This distribution does not correspond with that of this order in the ancient geological floras of Europe. It may perhaps explain the scarcity of the species of the *Laurineæ* in North America.

As far as it can be ascertained from fossil specimens, the origin of this order is in the Cretaceous of both continents. Prof. Heer has described a species of *Sassafras* from the Upper Cretaceous of Greenland, and three species of *Daphnophyllum* from that of Moletin; d'Ettingshausen has recognized a *Laurus* and a *Daphnogene* in that of Niedershoena, Saxony. As North America has afforded until now more materials for the study of dicotyledonous plants of the Cretaceous than Europe, it is a matter of course that the number of leaves referable to *Laurineæ* is proportionally large in this formation. Thus we count in the plants of the Dakota group of Kansas and Nebraska, as far as they are known to this time, ten species described under the generic names of *Laurus*, *Persea*, *Daphnogene*, *Oreodaphne*, and *Sassafras*.*

On the contrary, when we consider the Tertiary floras of both continents, we find an extraordinarily great difference in the distribution of the *Laurineæ* in favor of the European side, where fourteen species from the Eocene and more than one hundred from the different stages of the Miocene have been described. Among these, four species of *Sassafras* are recorded, while, though a predominance of leaves referable to this genus is remarked in the Cretaceous of the Dakota group, no remains of plants positively referable to *Sassafras* have as yet been found in the North American Tertiary. A mere fragment of a leaf has been doubtfully referred to it, but its characters are too obscure to be considered as evidence. It is a peculiarity of distribution, which has a remarkable correlation with that of the genus *Liriodendron*, which, although widely distributed in the Cretaceous of Nebraska, has only, like *Sassafras*, one species predominant in the flora of our time, and has not been observed until now in the North American Tertiary. These anomalies in regard to the distribution of the species in the geological periods may be merely illusive, or a consequence of insufficient knowledge with the Tertiary flora of this country; and possibly fossil leaves referable to these genera may be found hereafter. They are, however, remarkable enough to merit a record in the documents relating to the history of the present flora.

All the species of *Laurineæ* from the American Tertiary may be referred

* I count only two species of *Sassafras*. The question of reference of the numerous leaves of *Sassafras* (*Araliopsis*) is as yet unsettled. (See Annual Report, 1874, p. 342.)

to the genera *Laurus* or *Persea*, *Tetranthera*, *Cinnamomum*, and *Daphnogene*. I have formerly described, from the Lower Lignitic Eocene of the Mississippi, one species of *Laurus*, two of *Persea*, and one *Cinnamomum*. A fragment described in the Geological Report of Prof. Safford, under the name of *Persea Carolinensis*, is, though positively referable to the *Laurineæ*, specifically unidentifiable. From the Rocky Mountain Lignitic, ten species are described here, all from specimens of the Eocene formation from Point of Rocks to Evanston. None has been observed at Carbon, and none in the Green River group. I have seen a large number of specimens of two species of *Laurus*, with two of *Cinnamomum*, from a Tertiary formation of Oregon (Coral Hollow), which, from the associated forms, seems referable to the Lower Lignitic. Heer has a *Laurus Colombi*, from Barras Inlet, British Columbia, probably of the same period. We could therefore consider all our American representatives of *Laurineæ* as Eocene, except for one species only, a *Persea*, closely related to the present *P. Carolinensis*, and found in the Upper Tertiary, or Pliocene Chalk Bluffs of California.

LAURUS, Linn.

Leaves penninerved, similar to those of the penninerved *Laurineæ*.

This definition is translated from the Sézanne Flora by Saporta. As I am unable to find any character, either in the form of the leaves or in their nervation, for the separation of *Laurus*, *Persea*, and other related genera, I describe, under this general, rather than generic, appellation, all the Lignitic species of *Laurineæ* represented only by penninerved leaves.

Laurus socialis, sp. nov.

Plate XXXVI, Figs. 1, 2, 3, 4, 7.

Leaves comparatively large, subcoriaceous, broadly lanceolate, obtusely acuminate or pointed, rounded or broadly cuneate to the petiole; lateral nerves slender, open, curved in passing to the slightly undulate borders; drupe globular.

I had originally considered all the leaves (figs. 1 to 8) as referable to the same species, *L. primigenia*, Ung., for the nervation, the areolation, and the petiole are all of the same character; and, in comparing the different forms and the variations of size of the leaves from a large number of specimens, the transitional links between them seemed to render their separation into two species extremely hazardous. Count Saporta, however, who has compared original specimens with these figures, admits two species, this one

having larger leaves, more obtuse at the base, less distinctly acuminate, than any of those referred to *L. primigenia*. It is well to remark that all the specimens represented in figs. 1–8 are from the same locality, found mixed together, sometimes plentifully, upon the same piece of shale. The large leaves, however (figs. 1 and 2), are rare; those like figs. 5 and 6 are the most abundant. In all, the areolation is generally obsolete, remarked only upon fragments whose epidermis has been destroyed by maceration.

The fruit (fig. 4 *a*) is, with others of the same character, found mixed with the leaves; it represents evidently the drupe of a *Laurus*, most probably of this or of the following species. By its globular form, it is similar to that of the present North American *Persea Carolinensis*. It is surrounded by a thin, shelly, or coriaceous pericarp, which is easily separated in fragments, as marked upon the figure.

HABITAT.—Evanston, Wyoming; in the shale, below the main coal.

Laurus primigenia, Ung.

Plate XXXVI, Figs. 5, 6, 8.

Laurus primigenia, Ung., Foss. Fl. v. Sotzka, p. 38, pl. xix, figs. 1-4.—Heer, Fl. Tert. Helv., ii, p. 77, pl. lxxxix, fig. 15; iii, p. 184, pl. cxlvii, fig. 10 c; cli i, fig. 3.—Sap., Ét., i, p. 210, pl. vi, fig. 5; ii, p. 89, pl. iii, fig. 8; iii, p. 75.—Ung., Foss. Fl. v. Kumi, pl. viii, figs. 1-7.—Heer, Sachs. Thur. Braunk., p. 7, pl. vi.—Ett., Alt. Braunk. d. Wetter., p. 44.—Lesqx., Annual Report, 1872, p. 406.
Laurus phœboides, Ett., Tert. Fl. v. Vien., p. 17, pl. iii, fig. 3.
Laurus obovata?, Lesqx., Annual Report, 1872, p. 399.

Leaves subcoriaceous, narrowly lanceolate, acuminate; lateral nerves slender, open, distinctly curving in passing to the undulate borders.

The first specimens referable to this species, found six miles above Spring Cañon, were very obscure, mere fragments, which did not afford any satisfactory evidence for identification or description. These were referred, with an imperfect specimen from Black Buttes, to this species and to *Laurus obovata*, Web. (Palæont., viii, pl. iii, fig. 4). Since then, I have had opportunity to examine more satisfactorily these leaves by the comparison of a large number of specimens at Evanston, but have been unable to positively recall to the same species the fragments from Spring Cañon and Black Buttes; they have been omitted as too unreliable. The difference of the characters of this species from those of the former is especially in the narrowly lanceolate, more distinctly acuminate, and narrowly cuneate shape of the leaves. The nervation and areolation are of the same character.

HABITAT.—Evanston, Wyoming; first collected by *Dr. A. C. Peale*.

Laurus ocoteoides, sp. nov.

Plate XXXVI, Fig. 10.

Leaf long, coriaceous, narrowly lanceolate, gradually tapering from below the middle upward to an obtuse acumen, cuneate to the petiole; lateral veins thin, open, subequidistant, close, slightly curved.

The smooth or polished surface of the leaf, its coriaceous substance, and its shape and nervation refer it to the *Laurineæ*, though nothing of its areolation may be discerned. It is fifteen centimeters long, three centimeters broad, a short distance above the base, where it is the widest, and hence gradually narrowed upward to an apparently obtuse point; for it is not clearly seen if the top is naturally truncate or if its abrupt termination is caused by fracture. The shape is very fine, and rarely observable in leaves of *Laurus*. Saporta has seen some of this character in species of the old genus *Ocotea*, now distributed among other subdivisions of the *Laurineæ*.

HABITAT.—Golden, Colorado. Only one specimen, here figured, has been found.

Laurus præstans, Lesqx.

Plate LXIII, Fig. 7.

Laurus præstans, Lesqx., Annual Report, 1874, p. 305.

Leaf large, coriaceous, very entire, elliptical-lanceolate, narrowed in the same degree upward to a sharp-pointed, slightly scythe-shaped acumen, and downward to the petiole; middle nerve very thick; secondary veins strong, equidistant, and parallel.

The preservation of the leaf is not quite perfect, its lamina being destroyed in the lower part. The border line is, however, clearly defined, as represented in the figure. It is sixteen centimeters long without the petiole, five centimeters wide in the middle, has its lateral veins on an acute angle of divergence, 40°, gradually curving in traversing the areas to the borders, which they closely follow in simple festoons. It has no distinct tertiary veins, but the veinlets are strong, mostly simple, or sparingly branched, with the interspaces filled with small polygonal areolæ, appearing all of the same ultimate degree. This leaf might be compared to many species of the European Miocene, *Persea speciosa*, Heer, *Laurus princeps*, Heer, etc., especially this last species as represented in Fl. Tert. Helv., pl. xc, fig. 20, by a leaf of about the same size. It is, however, distinctly characterized by its equidistant secondary nerves, without intermediate tertiary ones; its strong veinlets, mostly simple, and especially its very thick midrib. This last character refers it to *Persea lancifolia*,* Lesqx. (Trans. Amer. Phil. Soc., vol. xiii, p. 419, pl. xix, figs. 3 and 4), represented by two leaves which are gradually

* Described as *P. lancifolia*; quoted by Schimper as *P. lanceolata*.

narrowed to an acumen and downward to the petiole, and have also the secondary veins distant and under the same angle of divergence. These leaves are comparatively smaller, however; their base is more prolonged into a very acute wedge, and, as the details of areolation are totally obsolete, the degree of relation between these forms cannot be positively ascertained. I do not know any leaf of *Laurineæ* with a midrib of the same thickness. In the present flora, *Laurus Canariensis*, Web., has the more marked affinity with this fossil species, especially by leaves of the variety *glaucescens*, one of which is figured by Heer (*loc. cit*). Except that the leaf described here is larger and has not any warts in the axils of the secondary nerves, the characters are much alike.

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Laurus Utahensis, sp. nov.

Plate XXVI, Fig. 11.

Leaves ovate, lanceolate-acuminate, rounded-cuneate to the petiole; secondary veins at an acute angle of divergence, inequidistant, parallel.

A single leaf, subcoriaceous and very entire, with the basilar secondary nerves opposite from a short distance above the base, at an angle of divergence of 25° to 30°, passing up nearly straight to quite near the borders. Except some veinlets in right angle to the nerves, the details of areolation are totally obsolete. By its nervation and its shape, this fine leaf is comparable to those of some living species of *Phœbe*, like *P triplinervis*, Gray, of Cuba, whose leaves, though generally smaller, have sometimes the same size as this one, which measures twenty centimeters in length and three and a half centimeters in width. The point is broken; but the direction of the borders shows it to be gradually acuminate. I do not find any fossil species evidently related to this.

HABITAT.—Bridger's Pass, Wyoming; in connection with *Araliopsis gracilis* and *Populus arctica* (*Dr. F. V. Hayden*).

Laurus Brossiana, Lesqx.

Plate XXXVI, Fig. 9.

Persea Brossiana, Lesqx., Annual Report, 1873, p. 407.

Leaf subcoriaceous, oval-oblong, rounded to a short acumen, cuneate to the petiole; secondary nerves strong, alternate, slightly curved, with small glands at the axils, brachiodrome.

For representative of this species, we have, as for the former, one leaf only, but it is also in a good state of preservation. Its size is about the same

as that of the former; the borders appear recurved; the secondary veins, on an angle of divergence of 30°, are very strong, deeply marked, the surface between them being bossed or irregularly convex, and their base is marked by small inflated dots, like the impressions of axillar glands. These veins are comparatively close, equidistant, and parallel from the base to above the middle of the leaf, the upper pair only being placed higher above; all are connected in their marginal bows by strong nervilles. Though distantly comparable to the former species, it greatly differs by its oblong shape, the thick lateral nerves, the glands, etc. This character relates it to the living *Laurus Canariensis*, from which it especially differs by its rounded, abruptly acuminate top. The midrib is narrow, at least comparatively to the thickness of the lateral nerves.

HABITAT.—Mount Brosse, Colorado, with a large number of specimens of *Araliopsis affinis* (*Dr. F. V. Hayden*).

TETRANTHERA, Jack.

Leaves entire, penninerved, with the characters of the *Laurineæ;* calix or involucre quadrifid.

Tetranthera sessiliflora, Lesqx.

Plate XXXIV, Figs. 1 *c*, 1 *d*; Plate XXXV, Figs. 8, 9.

Laurus sessiliflora, Lesqx., Annual Report, 1873, p. 407.

Leaves subcoriaceous, small, obovate-lanceolate, obtusely pointed; lateral veins distinct, open, the lowest pair at a more acute angle of divergence; receptacle sessile, four-lobed, lobes entire, acute; fruits oval, nutlets striate, pericarp smooth, detaching in fragments.

I consider all the fragments represented upon the specimen in fig. 8 as referable to the same species. The leaves, five to six centimeters long, proportionally broad, oblanceolate in fig. 8 *a*, oblong-lanceolate in fig. 9, gradually narrowed to the petiole, rounded and narrowed upward to an obtuse point, are distinctly nerved. The lower pair of secondary veins is more oblique, ascends higher in following the borders; the others, diverging from the midrib at an angle of 40° to 50°, are curved, parallel, inequidistant, joined by strong, mostly simple nervilles, all following quite near the borders in simple bows. The involucre *b* is evidently sessile, quadrilobate, with the divisions comparatively long (five millimeters), and apparently joined at the base, tapering to an obtuse point. The berries *c*, *d*, five millimeters broad and eight long, are ovate, obtuse, with a smooth or obscurely lined surface. The fragment of a branch in fig. *e* has its surface of the same character as the branchlet

in fig. *d*, which bears seeds without involucre, and thus seems to belong to the same plant.

This species is remarkably similar to the living *Tetranthera laurifolia*, Jacq., by the lanceolate or oblanceolate shape of the leaves, with secondary veins distributed in the same manner, and very distinct like the nervilles, the areolation being less marked, and discernible only with a strong glass; the flowers, sessile upon the branchlets, have the quadripartite involucre with lobes of the same form as in their fossil fragments, only slightly shorter, and overlapping at the base, or apparently connected as in fig. *b*. The specimens which I have for comparison are from Japan and from Cuba. These last ones, to which the fossil species is similar, represent the var. *saligna* of the Prodromus, which indicates its habitat in Ceylon. As the species is often cultivated in the tropical islands, it may have been introduced into Cuba.

HABITAT.—Evanston, Wyoming, with *Laurus primæva*, from which it is easily separated by the distinct nervation. The specimen belongs to *Mr. Wm. Cleburn*, to whom I owe its communication. The fruits (pl. xxiv) are from the same locality, and seem clearly to represent the same species. They are only a little smaller

CINNAMOMUM, Burm.

The leaves of the species of this genus, which is now distributed in the equatorial regions of East India, China, and Japan, are distinct from those of the other *Laurineæ* especially by the triple or palmate divisions of their nerves. The two lateral nerves go out from the base of the midrib, ascending toward the top of the leaves in a curve, without reaching the point. Sometimes they bear at the base one pair of marginal veinlets, and also sometimes another intermediate pair, emerging from the midrib under the primary lateral nerves, and nearly as strong but shorter, and without branches. This last character is not indicated in the description of the leaves of this genus, and has not been remarked in fossil species published by European authors. But it is distinctly seen upon some leaves of *Cinnamomum Zeylanicum*, exactly the same as upon one of the leaves described here.

Eighteen fossil species are described by European authors, distributed from the Upper Eocene of the Gypses of Aix to the Upper Miocene of Œningen, etc., mostly in the southern parts of France and Germany, and in Switzerland and Italy. None has been described in the Baltic flora, and none

in that of Greenland. The origin of the genus is therefore generally considered in Europe as Tertiary, rather Miocene. Two leaves described in the Cretaceous Flora, vol vi of the Reports of the Geological Surveys of the Territories, p. 83, pl. xxx, figs. 2, 3, have been found by Prof. B. F. Mudge in concretions of the Cretaceous Dakota group; and though their identity with *C. Scheuchzeri*, Heer, of the Miocene, is doubtful, they seem truly referable to this genus. Another Cretaceous species has been also described as *C. Heerii* in Trans. Am. Phil. Soc., vol. xiii, p. 431, pl. xxiii, fig. 12, from an incomplete specimen. The evidence of the old origin of the genus is confirmed by the presence of most of our species of *Cinnamomum* in the lower strata of the Eocene Lignitic, where the best specimens have been found, especially at Golden, in the White Sandstone underlying the coal beds, in close proximity to strata bearing Cretaceous animal remains.

Cinnamomum lanceolatum?, Ung.

Plate XXXVI, Fig. 12.

Cinnamomum lanceolatum, (Ung.) Heer, Fl. Tert. Helv., ii, p. 86, pl. xciii, figs. 6–11.—Ludw., Palæont., viii, p. 109; pl. xliii, figs. 1–7.—Massal., Fl. Senog., p. 265, pl. viii, figs. 2–4; xxxiii, fig. 9.—Sism., Contr., p. 52, pl. xxiv, figs. 5, 6, xvi, fig. 7.—Sap., Ét., i, p. 89; ii, p. 90.—Ett., Fl. v. Bil., p. 198, pl. xxxiii, figs. 7–9, 13, 16.—Ung., Foss. Fl. v. Kumi, p. 30, pl. vii, figs. 1–10.

Daphnogene lanceolata, Ung., Foss. Fl. v. Sotzka, pl. xvi, figs. 1–4.—Web., Palæont., ii, p. 183, pl. xx, fig. 6.—Ett., Foss. Fl. d. M. Prom., pl. vii, figs. 3–7.

Leaf lanceolate, acuminate upward, narrowed downward to the petiole, triple-nerved; lateral veins obscure, apparently acrodrome.

The fragment as seen by our figure is too incomplete for positive identification. The lateral veins do not follow the borders as closely as it is generally the case in this species; it might be referable to *C. Scheuchzeri*, Heer, but for the apparently narrowly cuneiform base. The nerves are too thin to authorize a reference to the following species.

HABITAT.—Evanston, Wyoming (*Dr. F. V. Hayden*).

Cinnamomum affine, Lesqx.

Plate XXXVII, Figs. 1–5, 7.

Cinnamomum affine, Lesqx., Annual Report, 1869, p. 196; 1872, p. 383; 1874, p. 401.

Leaves oval-acuminate, rounded and narrowed to the petiole, triple-nerved; nerves thick, the lateral ones curving nearly parallel to the borders, but at a distance, slightly branching.

The leaves, generally oval, like those of *C. polymorphum*, Al. Br., to which this species is related, are narrower and more gradually acuminate; the nervation is of the same type, but none of our specimens has any trace of the axillary glands remarked in the European species; the divisions of the

nerves into branches is also far less defined. The leaf of fig. 7 appears, by the addition of one pair of lateral nerves, to represent a different species. It is, however, found upon the same piece of shaly hard sandstone as the leaves of figs. 1–3; and from an analogous distribution of the nervation, in leaves of species of our time, as remarked above, it is evident that it cannot be separated. Except this casual addition of a lower pair of nerves, the characters are exactly alike. I have been for a long time undecided in regard to the possible identity of this northern species with the beautiful *Cinnamomum Mississippiense*, Lesqx., communicated by Prof. Eug. W. Hilgard, and described in Trans. Amer. Phil. Soc., vol. xiii, p. 418, pl. xix, fig. 2. From the larger size of the Mississippi leaf, more enlarged below the middle, its more rugose nervation, and the greater distance of the lateral nerves from the borders, I came to the conclusion that the leaves of Golden did represent a new species, or at least a diminutive variety of *C. Mississippiense.* This may be an error. Even as the relation of all these leaves to those described by European authors as *C. polymorphum* is evident, we may have a simple variety. In that way, it would be necessary to unite in one some other species like *C. spectandum*, Sap., *C. spectabile*, Heer, which bears to *C. Mississippiense* as marked a relation as that of *C. affine.*

HABITAT.—Golden, Colorado, where the fine large specimen was discovered and communicated by *Capt. E. Berthoud.* A specimen also, with a number of leaves of the same character, has been lately sent by *Rev. A. Lakes.* The specimen of fig. 4 is the first obtained, and already mentioned in the Annual Report of 1869. It is from Marshall's Mine, Colorado (*Dr. F. V. Hayden*). I found others also at Carbon, Wyoming. The species has a wide distribution.

Cinnamomum Scheuchzeri?, Heer.

Plate XXXVII, Fig. 8.

Cinnamomum Scheuchzeri, Heer, Fl. Tert. Helv., ii, p. 35, pl. xci, figs. 4–24; xcii, xciii, figs. 1, 5.—Lesqx., Annual Report, 1871, p. 29.

Leaf small, oblong-lanceolate, cuneate to the petiole; lateral veins joining the midrib in a curve, ascending parallel to the borders, scarcely branching; nervilles distinct, in right angle to the midrib.

Though the characters of the species are recognized in this fragment by the small size of the leaf, its comparatively broadly cuneate base, and the union of the lateral nerves to the midrib high above the base and in a curve, I am not positive about its specific relation, the less so that we have until

now no other American specimens positively representing this species. All the others formerly considered as referable to it had to be eliminated, either on account of their too incomplete state of preservation or as forcibly passing by transitions to *C. affine.*

HABITAT.—Spring Cañon, Montana (*Dr. F. V. Hayden*).

Cinnamomum polymorphum, Al. Br.

Plate XXXVII, Figs. 6, 10.

Cinnamomum polymorphum, Heer, Fl. Tert. Helv., ii, p. 88, pl. xciii, figs. 25–28; xciv, figs. 1–26; iii, p. 185.—Ludw., Palæont., viii, p. 110, pl. xlii, figs. 1–11.—Sap., Ét., ii, p. 278; iii, p. 173, pl. v, figs. 1–4.—Massal., Senogal., p. 263, pl. vii, figs. 10–13; viii, figs. 5–9, 11, 12, 16, 17; xxxviii, fig. 19.—Sism., Mém. Pal., p. 52, pl. xxiv, figs. 2–4; xxv, fig. 4.—Ett., Bil. Fl., p. 198, pl. xxxiii, figs. 14, 15, 17–22.

Ceanothus polymorphus, Al. Br., Stizenb. Verzeich., p. 88.

Ceanothus subrotundus, Ung., Chlor. Protog., p. 144, pl. xlix, fig. 7.—O. Web., Palæont., ii, pl. xxiii, fig. 6.

Daphnogene polymorpha, Ett., Tert. Fl. v. Wien (*ex parte*), p. 16, pl. ii, figs. 22–23; Foss. Fl. d. Monte Prom., p. 14, pl. vi, figs. 1–8.

Daphnogene cinnamomifolia, Ett., Foss. Fl. d. Monte Prom., p. 15, pl. vii, fig. 8.

Camphora polymorpha, Heer, Fl. Tert. Helv., i, p. 112.

Phyllites cinnamomeus, Rossm., Verstein., pl. i, fig. 1.

Cinnamomum Rossmässleri, Lesqx., Annual Report, 1872, p. 379.

Leaves of medium size, variable in form, generally oval, rounded to a short acumen, broadly cuneate to the petiole; lateral nerves thick, branching outside, joining near the borders the divisions of the midrib.

As seen by the quotation of Heer's figures in Report (*loc. cit.*), the reference was made by error of names, for the characters of these two leaves relate them distinctly to *C. polymorphum* or perhaps to *C. affine.* The leaves of *C. polymorphum* are comparatively broader, abruptly narrowed into a sharp acumen; the branches of the lateral nerves are more numerous, at a more open angle of divergence, generally joined by fibrillæ to nervilles in right angle to the borders. In the leaves which I refer to this species, the surface is coarser, cut by deeper nervilles, the midrib more divided than in *C. affine.* But the essential characters of *C. polymorphum* are not sufficiently distinct upon our specimens, none of them having the upper part of the leaves or the acumen preserved, and the areolation and fibrillæ of the borders being obsolete. Therefore, we may have, in the two leaves referred here to *C. polymorphum*, mere varieties of *C. affine*, and thus it may be that all the American *Cinnamomum* leaves represent only one species. For this reason, I have omitted the numerous references to European authors for *C. Scheuchzeri*, described as it is above from too obscure specimens.

HABITAT.—Golden, Colorado.

DAPHNOGENE, Ung. (emend.).

The leaves referred to this genus are similar in form to those of the narrow-leaved *Cinnamomum*. They are described as *entire or trilobate, tripli-nerved, with the lateral nerves sub- or suprabasilar and the branches distant, camptodrome or brachiodrome.*

Daphnogene anglica, ?Heer.

Plate XXXVII, Fig. 9.

Daphnogene anglica, Heer, Fl. Tert. Helv., iii, p. 315 (note).
Daphnogene anglica?, Lesqx., Annual Report, 1873, p. 401.

Leaf lanceolate-acuminate; lateral veins subbasilar, acrodrome, distant from the borders, and distantly ramose; nervilles close, in right angle to the nerves, distinct.

Prof. Heer briefly describes the leaves of this species, not figured, as ovato-lanceolate, long-acuminate, triple-nerved; middle nerve and secondary ones branching. Our leaf is only lanceolate; the midrib is not branching, though another fragment has some branches, and even, in the one figured here, some thin branchlets appear, cutting obliquely the nervilles in the upper part of the leaf. The evidently acrodrome nervation of the specimen of fig. 9 is not seen upon any of the species of *Daphnogene* described and figured by European authors except in *D. Kanii*, Heer (Fl. Foss. Arct., p. 112, pl. xiv, xvi, fig. 1), whose reference to this genus is doubtful. It is therefore probable that, as Saporta supposes, this leaf may represent a *Zizyphus* or a *Ceanothus;* but I do not find in any of these generic divisions a species to which it is seemingly related.

HABITAT.—Golden, Colorado (*Capt. Ed. Berthoud*).

GAMOPETALÆ

LONICEREÆ.

VIBURNUM, Linn.

This genus, which counts at our epoch more than fifty species, has its origin marked in the Eocene; at least, no *Viburnum* leaves have been described until now from the Cretaceous.* The largest number of its living species belongs to Asia, twenty-four; North America has twelve; Japan, five; Europe, only three: a remarkable difference with the Tertiary flora of the same country, from which at least ten species have been described.

* Count Saporta finds, however, a remarkable affinity between a species of the Dakota group, *Ampelophyllum attenuatum*, Lesqx. (Annual Report, 1874, p. 354, pl. ii, fig. 3), and some leaves, described by himself as *Viburnum vitifolium*, from the Lower Eocene of Gelinden. This relation is pointed out in a letter of the celebrated author, his work, a second volume of the Flora of Gelinden, being now in course of publication.

The oldest type of *Viburnum* is that of the *Lantanoides*, represented in the North American flora by *V. lantanoides*, *V. molle*, and *V. dentatum*. The species here described are related to it, as is also the one described in the Eocene Sézanne Flora by Saporta, *V. giganteum*, whose affinity with the plants from Black Buttes is marked. Dr. Newberry has described, from the Tertiary of the Union group, two species with small leaves. Their relation to this section is less positive; they rather seem allied to *V. nudum*, var. *pyrifolium*, of the present North American flora.

Viburnum marginatum, Lesqx.

Plate XXXVII, Fig. 11; Plate XXXVIII, Figs. 1–5.

Viburnum marginatum, Lesqx., Annual Report, 1872, p. 395; 1873, p. 401; 1874, p. 306.—Sch., Pal. Végét., iii, p. 601.

Leaves of large size, petioled, broadly obovate, generally enlarged upward from the base and round, subtruncate, short-pointed at the top, equally dentate from above the middle; basilar veins opposite, oblique, ramified, as also their divisions, craspedodrome.

Most of the leaves representing this species are large, some still larger than that of fig. 1, all recognizable by a black border, not inflated, surrounding them; their consistence is rather thick, but not coriaceous. Broadly cuneate to the petiole, and widely enlarged toward the middle or higher above it, they are either nearly truncate and short-pointed, or rounded to a point. The borders are equally dentate, with short, regular teeth, turned outside, separated by shallow sinuses, and each entered by the points of the nerves or of their divisions. The nervation is strong and very distinct, generally blackened like the borders; the basilar veins, opposite from quite near the base, very oblique, 25° to 30°, branch three or four times outside, the branches dividing once or twice, as also the other lateral nerves, and thus all the divisions enter one of the teeth. The principal nerves are joined by strong nervilles at right angles, and generally simple; the details of areolation are obsolete. Fig. 11 of pl. xxxvii is nearly entire, merely denticulate at the rounded top, and thus the branches of the lower nerves are camptodrome. This is evidently a mere deviation from the general type, as we see in figs. 1 and 2 of pl. xxxviii the same character marked by the tertiary nerves along the base as far up as it is entire. This leaf has been described in the Annual Report, 1872, p. 396, as *V. contortum*. A deviation of another kind is marked in fig. 3, where the lower pair of nerves do not branch, but which has the teeth entered by divisions of the nervilles. Fig. 4 represents a leaf with a comparatively long petiole. The connection, where it is broken below the base of the leaf, is not clearly seen; the petiole

of fig. 1 is broken; those of figs. 2 and 3 are short, though apparently preserved in their whole length. The longest petioles of the leaves of the present *V. dentatum*, L., are not more than half that of fig. 4. As seen in comparing fig. 5 and fig. 1, the size of the leaves is extremely variable.

By the mode of division of the borders or of the teeth, this species resembles *V. dentatum;* but its nervation is like that of *V lantanoides*, Michx., the veins and the borders being apparently covered by a thick coating of vellosity, which by fossilization gives them the black color as remarked above. The cuneate base is, however, a character not remarked upon any of the allied living American species, except in a less degree in *V. ellipticum* of Oregon. It is quite distinct in *V. erosum*, Thb., of Japan, whose leaves, as large as those of the fossil species, are ovate, lanceolate-acuminate, and have the border teeth of a different character.

HABITAT.—Black Buttes, Wyoming, very abundant; found also at Point of Rocks, Wyoming (*Wm. Cleburn*); Golden, Colorado, where it is very rare.

Viburnum platanoides, Lesqx

Plate XXXVIII, Figs. 8, 9.

Viburnum platanoides, Lesqx., Annual Report, 1874, p. 314.

Leaves large, angular, tapering upward from the enlarged middle, rounded or truncate to the petiole; borders equally dentate; nervation coarse and thick, craspedodrome.

The facies of these leaves is Platanoid; the middle vein is thick, the lateral veins proportionally so, joining the midrib at or quite near the border base of the leaves, at an angle of divergence of 40° to 50°, nearly all parallel, the lowest ones slightly more prolonged to the borders into an indistinctly marked lobe; all branching more or less, and entering the points of the teeth, either directly or by their divisions. Though somewhat similar to those of *Platanus aceroides*, Heer, these leaves are of the same type as those of the former species, differing by the obtuse or truncate base, the thick, less numerous, secondary nerves, and the broadly cuneate points. The borders are not blackened, the consistence still thicker, and the surface very coarsely furrowed by the veins and strong. distant nervilles, which are more generally divided in the middle.

HABITAT.—Black Buttes, Wyoming, in the burned bed where the remains of the Saurian *Agathaumas sylvestris*, Cope, were found, fragments of these leaves being glued to the bones. I considered the first found as referable to *Platanus aceroides*, their borders and outline being destroyed and the nervation only discernible.

Viburnum rotundifolium, Lesqx.

Plate XXXVII, Fig. 12; Plate XXXVIII, Fig. 10; Plate LXI, Fig. 22.

Viburnum rotundifolium, Lesqx., Annual Report, 1874, p. 305.

Leaves small, nearly round, surrounded by a black border, dentate, rounded-subcordate at the base; nervation thin, camptodrome.

Except that the leaves are all small, nearly round, subcordate or truncate at the base, and the nerves thin, the characters of these leaves are the same as those of *V. marginatum*. They are generally unequal at the base, and the basilar secondary veins emerge from the top of the petiole; the teeth are, comparatively to the size of the leaves, quite as distinctly marked as in the former species. Saporta considers this and the following as referable either to *V. marginatum* or to *V. platanoides*.

HABITAT.—Black Buttes, Wyoming, where it is rare; Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Viburnum dichotomum, Lesqx.

Plate XXXVIII, Fig. 6.

Viburnum dichotomum, Lesqx., Annual Report, 1872, p. 399.—Schp., Pal. Végét., iii, p. 601.

Leaf subcoriaceous, oval, obtuse, rounded to the petiole; borders dentate; secondary nerves alternate.

The consistence of this leaf is somewhat thicker than that of the above-described congeners. The distribution of the secondary veins is quite different, as they come out alternately, and are like dichotomous divisions from a series of flexures of the midrib. Except this, there is no marked difference in the nervation. The oval form of the leaf, rounded at the base, is also peculiar to this leaf, which may be a variety of *V. marginatum*. Its borders, however, are not black-margined, and the surface is smooth. It closely resembles, by its characters, *V. ellipticum*, Hook., of Oregon.

HABITAT.—Black Buttes, Wyoming, baked shale.

Viburnum Whymperi?, Heer.

Plate XXXVIII, Fig. 7; Plate LXI, Fig. 23.

Viburnum Whymperi, Heer, Fl. Foss. Arct., ii, p. 475, pl. xlvi, fig. 1; Spitz. Fl., p. 60, pl. xiii, figs. 3–23.—Lesqx., Annual Report, 1872, p. 395.

Leaf oblong, obtuse, or subtruncate, rounded to the base; borders denticulate; secondary veins thin, numerous, irregularly divided, craspedodrome.

This reference is doubtful. These leaves differ especially from those of the former species by the more numerous, close, smaller teeth, and by

the multiplied, irregular disposition and divisions of the lower lateral veins. By these characters, they are similar to that described by Heer from North Greenland (fig. 1 *b*, *loc. cit.*). This analogy is, however, not sufficiently definite. The secondary nerves, not blackened, are thinner and more irregularly divided than in *V. marginatum*, and the shape is quite different. The relation to the species of Greenland is therefore closer or more defined than to *V. marginatum* and its varieties.

HABITAT.—Black Buttes, Wyoming, with *V. marginatum;* Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Viburnum Lakesii, Lesqx.

Plate XXXVII, Fig. 13.

Viburnum Lakesii, Lesqx., Annual Report, 1873, p. 401.

Leaf coriaceous, round in outline, and apparently trilobate, round-truncate to the petiole, dentate, palmately three-nerved.

The only leaf which represents the species is broken in such a way that its outlines cannot be positively defined. From the character of the nervation toward the point, and also from the obtuse sinus at the right side of the upper border, it is evidently trilobate, the lobes being probably short and obtuse. The substance of the leaf is truly coriaceous, the teeth sharp, turned upward, and not outside, as in the former species, cartilaginous or membranaceous at the point. The primary lateral nerves are thick and much divided outside, and their divisions, branching also, are straight, at an open angle of divergence, and in the same relation to the border teeth as in the former species; the secondary veins, a little more distant from the primary ones, are nearly parallel to it, and also divide and enter the teeth by their branches. In comparing this fragment to those of pl. xxxviii, figs. 8 and 9, described as *V. platanoides*, the same type of nervation is at once recognizable, for these also have a subtrilobate form and a corresponding distribution of the primary and secondary nerves and of the veinlets. The difference is, however, clearly marked in the more distinctly trilobate shape, the coriaceous substance, and the direction upward of the small cartilaginous teeth. The Platanoidal character is still more evident in this species.

HABITAT.—Golden, Colorado (*Rev. A. Lakes*).

Viburnum anceps, sp. nov.

Plate XXXVIII, Fig. 11.

Leaf coriaceous, rounded and acuminate at the top, gradually narrowed downward, palmately three-nerved, coarsely obtusely dentate upward.

A mere fragment, referable to the former described species by its coriaceous substance only. The leaf is apparently gradually narrowed to the petiole, in the same way as in fig. 1 of the same plate. It has also, like it, a rounded flat top, with a short acumen; but the consistence is thicker, the nervation tripalmate, and the teeth larger. irregular, and obtuse rather than pointed. It has only one pair of secondary nerves, opposite, placed in the upper part of the leaf, and simple. Though evidently a representative of this genus, it seems specifically different from the congeners described above.

HABITAT.—Golden, Colorado.

Viburnum Goldianum, sp. nov.

Plate LX, Figs. 2–2 *c*.

Seeds oval, obtuse, flattened, smooth, short-pediceled.

These small fruits, very numerous upon the clay of the same locality of a limited area, are referable by their characters to this genus. They appear to have been surrounded by a fleshy envelope, which, though destroyed in the fossil state, has left its original shape molded in the soft clay. The molds are, therefore, concave inside, and even some of the seeds are inflated on the surface, though always more or less flattened. Figs. 2 *b* and 2 *c* represent enlarged the more general forms of these seeds. The size, not very variable, averages four millimeters in width and six to seven in length.

HABITAT.—Golden, Colorado, in soft plastic clay.

Viburnum solitarium, sp. nov.

Plate LX, Fig. 3.

Seed large, ovate, obtusely pointed, short-pediceled, flattened.

This species is closely related to *V. macrospermum*, Heer (Spitzb. Fl., p. 60, pl. xiii, figs. 24–28). It is still somewhat larger and more regularly ovate.

HABITAT.—Golden, Colorado. Found separate, in connection with the fragment of leaf of pl. xxxviii, fig. 11, in coarse, sandy clay.

This seed represents evidently a species different from that to which the seeds of fig. 2 are referable. It would, therefore, be inadvisable to consider all the leaves of *Viburnum* described here as representing the same species. The living *V. molle*, *V. pubescens*, *V. dentatum*, *V. lantanoides*, and *V. ellipticum*

are quite as closely related by the forms and the nervation of their leaves as are those which have been described and figured here. I therefore consider them as representing different species, though great may be the analogy of their characters.

ASCLEPIADINEÆ.

OLEACEÆ.

FRAXINUS, Tournef.

The impari-pinnate leaves of this genus have ovate-lanceolate, generally acute or accuminate, leaflets, entire or more or less regularly denticulate, with a subcamptodrome nervation, the secondary nerves being joined to the dentate borders by nervilles from their bows, or directly entering them.

The genus has a number of species distributed in Europe, Asia, and especially the North American continent, to which forty-five of them are ascribed in De Candolle's Prodromus. But the number has been greatly reduced by a more careful determination, especially of the fruits; for of the thirty species described from the United States in that work, we find now only six admitted in Gray's Flora. This number, still considerable, accords with that of the fossil species known until now from this continent; for two are described and figured here, one of them common to Europe, the Baltic Flora, and Greenland; and two others are described only from specimens received too late for illustration. One from Golden is typically allied to the present *F. Americana*, by numerous leaves, which, either entire or sparingly dentate, are still larger, and of the same shape and nervation; and another, represented by a single leaf from the Upper Miocene of the Parks, seems also distinctly referable to this genus. The European authors have described seventeen species, all Miocene The species from Golden relates the origin of *Fraxinus* to the Eocene.

Fraxinus denticulata, Heer.

Plate XL, Figs. 1, 2.

Fraxinus denticulata, Heer, Fl. Foss. Arct., i, p. 118, pl. xvi, fig. 4; xlvii, fig. 2; Mioc. Balt. Fl., p. 89, pl. xii, fig. 27; xxiv, figs. 25–27.—Lesqx., Annual Report, 1872, p. 407.

Leaves oblong, obtusely pointed, gradually narrowed to the sessile base.

Our leaves are small, of the same size and form as those described from Greenland, the secondary veins curving near the borders, with nervilles passing to the teeth from the bows, as in fig. 4 of pl. xvi in the Greenland Flora;

the teeth of the borders are rather obtuse and distant. The leaves from the Baltic Tertiary are narrower. The broad base of fig. 2 shows the leaf to be sessile.

HABITAT.—The fragment represented by fig. 1 is from Evanston, Wyoming; that represented by fig. 2 from six miles above Spring Cañon, Montana (*Dr. A. C. Peale*).

Fraxinus prædicta, Heer.

Plate XL, Fig. 3.

Fraxinus prædicta, Heer, Fl. Tert. Helv., iii, p. 22, pl. civ, figs. 12, 13; Mioc. Balt. Fl., p. 89, pl. xxiv, fig. 24.—Lesqx., Annual Report, 1873, p. 414.

Leaf small, lanceolate and acuminate upward, narrowed to the base, distantly irregularly denticulate; secondary nerves camptodrome, joined to the teeth by nervilles.

The fragment represents a small leaf about four centimeters long, twelve millimeters broad, with a coarse irregular nervation, very similar to that of fig. 13 *b* of Heer's (*loc. cit.*). The only difference in the characters of this leaf is its more attenuated base, more narrowly cuneate than in any of the leaves figured by the author. I consider it, however, as representing the same species.

HABITAT.—South Park, near Castello's Ranch, Colorado (*Dr. F. V. Hayden*).

Though the two new species mentioned above are not figured here, I give a short description of those fine leaves.

Fraxinus Eocenica, sp. nov.

Leaves of large size, subcoriaceous, distantly obtusely dentate or merely undulate on the borders, broadly lanceolate, rounded in narrowing to the inequilateral base; nervation subcamptodrome.

The largest of these leaves is about fifteen centimeters long (the point is broken), and five centimeters broad below the middle, where it is the widest; the other leaves are somewhat smaller, exactly of the same form. The secondary nerves, on an open angle of divergence, nearly parallel and equidistant, generally curve in passing toward the borders, where they form, close to them, a series of simple bows, from which emerge the nervilles, which enter the blunt distant teeth. A few of these secondary nerves, however, curve and enter the point of the teeth; they have generally also a few branches in the upper part. The nervilles are distinct, irregular in direction, much divided; the areolation, as far as it is discernible, is in irregularly polygonal meshes. The base of the leaf is cuneate on one side, descending lower, and rounded on the other, or rounded on both sides, which then are nearly equal;

the upper part is gradually tapering upward, and then contracted to a slightly obtuse acumen, as in the leaves of *F. pubescens*, Lam., and *F. Americana*, Linn., to which this fossil species is related.

HABITAT.—Golden, Colorado; communicated in fine specimens by *Rev. A. Lakes.*

Fraxinus Brownellii, sp. nov.

Leaf large, apparently oval, obtuse, obliquely truncate on one side at the top, and obtuse on the other, rounded to the inequilateral base; borders denticulate.

The leaf, of which the point is apparently broken, is nine centimeters long, and five centimeters broad in the middle, rounded to the base, and descending deeper on one side than on the other. The borders are marked, especially in the middle, by small sharp teeth, close and turned upward. By this character and its shape, it greatly differs from the former species, as also by its apparently thin texture; the nervation only is of the same type. This leaf, perhaps deformed by compression, is irregular in its outlines; contracted above the middle on one side, it seems obliquely cut at the top on the other. Though much larger, it is comparable to *F. Ulmifolia*, Sap. (Ét., iii, p. 91, pl. ix, figs. 17–19), whose leaves, irregular, also have a similar kind of nervation, and the borders sharply serrate. The teeth are longer and more irregular in the European species than in the one received from the Miocene of the Rocky Mountains.

HABITAT.—Castello's Ranch, near South Park, Colorado (*Prof. W. A. Brownell*).

DIOSPYRINEÆ.

EBENACEÆ.

DIOSPYROS, Linn.

The numerous species of this genus are now, with few exceptions, tropical and equatorial, especially distributed in Asia and on the Eastern and Western Indian Islands. Europe has none in its present flora; North America has only one, the well known Persimmon, *Diospyros Virginiana*, Linn., which inhabits the Atlantic slope from Florida to Southern New York, middle of Ohio, etc. Japan has one also, *D. Kaki*, Linn., whose fruits are extremely pleasant to the taste. In the geological times, the genus was apparently widely distributed in the northern hemisphere. From the Cretaceous formations, already, Prof. Heer has described one species from Greenland, and another from the Dakota group of Nebraska, where two others still have been recognized, and published in the Cretaceous Flora, vol. vi of the Reports of the

United States Geological Survey of the Territories. The Cretaceous of Europe has none as yet, but there numerous species have been found in the Eocene, with leaves and fruits, especially described by Saporta from the Gypses of Aix; and, as we find the genus represented also in the North American Eocene, even in its lowest strata of Point of Rocks, its origin may be undoubtedly ascribed to the Cretaceous. The type is preserved by a still larger number of species in the Miocene of Europe, where it even passes to the Pliocene; for Saporta and Marion, in the Flora of Maximieux, describe a *D. protolotus*, which is closely allied to the living *D. lotus*, and *D. Virginiana*, Linn. Its presence in the Tertiary of Greenland is marked by two species; and on this continent it is recognized in the Miocene of Bellingham Bay and Barrard Island by one species, also seen at Evanston and in Alaska; and by those which are described here, one of which is from the Upper Miocene of the Parks of Colorado. None, however, has been observed until now in the Pliocene of California.

Diospyros? ficoidea, Lesqx.

Plate XL, Figs. 5, 6.

Diospyros? ficoidea, Lesqx., Annual Report, 1874, p. 314.

Leaves of a thick substance, ovate, lanceolate, or acuminate (point broken), rounded in narrowing to the base, deeply, coarsely nerved, camptodrome.

The two fragments figured here have the nervation deeper and thicker than in most of the fossil species referred to this genus. The numerous parallel and equidistant lateral nerves, at an angle of divergence of 30°, are nearly straight from the base to near the borders, where they curve in a series of bows, either simple, more rarely double, joined by strong distinct nervilies, nearly in right angle. The nervilles divide also mostly in right angle, by veinlets of the second order, forming, by branchlets in the same direction, irregularly quadrate or polygonal meshes (fig. 5 *a*). The coarseness of the nervation and the rough surface give to the leaves the appearance of those of some species of *Ficus*. The same is, however, remarked upon the leaves of *D. anceps*, Heer, Fl. Tert. Helv., as represented in pl. cii, fig. 16, to which this species seems closely related.

Habitat.—Black Buttes, Wyoming (*Prof. F. B. Meek*). I found the fragment of fig. 6 at the same locality with a smaller more indistinct one, the base of a leaf with a short petiole. As seen in the figure, the nerves are broader than in the leaf of fig. 5.

Diospyros brachysepala, Al. Br.

Plate XL, Figs. 7-10; Plate LXIII, Fig. 6.

Diospyros brachysepala, Al. Br., Bronn & Leon., Jahrb. f. Mineral., 1845, p. 170.—Ung., Blattabdr. v. Swoszowice, pl. xiv, fig. 15.—Heer, Fl. Tert. Helv. iii, p. 11, pl. cii, figs. 1-14; cliii, fig. 39 *b*; Fl. Foss. Arct., p. 117, pl. xv, figs. 10-12; xvii, figs. 5, *h*, *i*; xlvii, figs. 5-7; Mioc. Balt. Fl., p. 84, pl. xxvii, figs. 1-6; xxviii, fig. 1; Fl. v. Bornst., pl. iii, figs. 7-8.—Sism., Mater., p. 55, pl. xvi, fig. 5; xix, fig. 3.—Ett., Foss. Fl. v. Bil., ii, p. 232, pl. xxxviii, fig. 28; xxxix, fig. 1.—Lesqx., Annual Report, 1872, p. 394; 1873, p. 401.

Diospyros latifolia, Al. Br., in Bruckm. Verz., p. 232.

Diospyros longifolia, Al. Br., in Stizenb. Verz., p. 83.

Tetrapteris Harpyarum, Ung., Foss Fl. v. Sotzka, pl. xxix, figs. 9, 10 (*folia*).

Getonia macroptera et petreæfolia, Ung., *ibid.*, pl. xxxiii, figs. 2, 3, 4, 8 (*folia*).

Getonia truncata, Göpp., Foss. Fl. v. Schossnitz, p. 37, pl. xxv, fig. 11.

Leaves petioled, elliptical, narrowed to a point or a short acumen, rounded and attenuated to the base, very entire; secondary nerves alternate, inequidistant, on an acute angle of divergence, more open toward the point.

The leaves of this species, though somewhat thick and membranaceous, are not as thick nor as coarsely veined as those of the former. They are as variable in form as those of the living *D. Virginiana*, either rounded or narrowed to the base, and far different in size. All the fragments which I consider as referable to the species represent it in some of its characters, even the point of fig. 8 in pl. xl, though it indicates a leaf smaller than any described from Europe; for the form agrees with figs. 4 and 5, pl. xxvii, of the Baltic Flora. As seen in our figs. 7 and 9, the base is attenuated or rounded, as represented by the leaves referred to this species by European authors.

HABITAT.—Golden, Colorado, and Black Buttes and Point of Rocks, Wyoming.

Diospyros Copeana, Lesqx.

Plate XL, Fig. 11.

Diospyros Copeana, Lesqx., Annual Report, 1873, p. 414.

Leaf very entire, obovate, gradually narrowed downward to a short petiole, rounded upward to an obtuse point; midrib thick, scarcely thinning upward; secondary veins thin, camptodrome.

The leaf is of small size, seven centimeters long and half as wide, not thick; the lateral veins, distinct though thin, at an open angle of divergence, are more or less curved in passing to the borders, where they form, by anastomose of the nervilles, a double series of bows; the intermediate tertiary veins are distinct; the areolation obsolete. By its gradually narrowed base, this leaf is different in form from the fossil species of this genus. In pl. iii, fig. 8, of the Bornstädt Flora, Heer represents, however, as *D. brachysepala*, one leaf whose base is narrowed as it is in this one. The characters of the nervation refer this new species to *Diospyros*.

HABITAT.—Elko, Nevada (*Prof. E. D. Cope*).

Diospyros Wodani, Ung

Plate LIX, Fig. 13.

Diospyros Wodani, Ung., Gen. et Sp., p. 435; Sillog. Plant., iii, p. 27, pl. ix, figs. 10 and 11.
Calycites hexaphylla, Lesqx., Annual Report, 1872, p. 402.

Calyx hexaphyllous, open; sepals linear, obtuse, two centimeters long, free to the base; surface striate.

When I first described this species, I did not consider it as possibly identical with that of Unger, described in the Genera et Species as pentaphyllous. I have since obtained his Silloge, where the species, represented as quoted above, appears really to have six sepals, like ours. Indeed, Unger's figures, compared to the one of our plate, do not show any difference, except that its sepals are more exactly linear, and not as enlarged in the middle. The difference is evidently caused by casual deformation in the fossilization; for one of the sepals of the specimen figured here is enlarged near the base, as if the borders were there expanded, while they are recurved above; one of the branches is equally enlarged in the upper part, and another on the right side, casually truncate, should, if preserved entire, have the same size and shape as those of Unger's species. His fig. 11 shows the same modifications of forms as ours.

HABITAT.—Evanston, Wyoming; one specimen only.

ERICINEÆ.

ERICACEÆ.

It is remarkable that in this order of plants, so generally and prominently represented in the floras of our time, we have thus far found so few fossil species in the North American Tertiary. Leaving out of consideration the exotic living species, which in South Africa and Brazil are counted by the thousand, we find described by the botanists of our time one hundred and twelve species in the flora of the United States alone. Their distribution is varied, according to climatic circumstances: the Northeast has sixty-seven, of which nineteen are proper to it; the South has fifty-five, fifteen of which are limited to this region; California has thirty peculiar western species in forty-one of its flora. This distribution should imply the presence of *Ericaceæ* in all the groups of the North American Tertiary, however different may have been the atmospheric influences at the epochs. A distribution of this kind is remarked in the European Tertiary, where the paleo-botanists have recognized more than seventy species referable to the genera which are still represented in the North American flora, and distributed about in equal proportion

in all the stages from the Upper Eocene to the Quaternary. None, however, have been described until now from the Lower Eocene floras, Sézanne, Gelinden; none also from the Cretaceous. Now we have in the North American Cretaceous flora already two species of *Andromeda*, while from that of the whole Tertiary we know only two: *A. Grayana*, Heer, recorded by the author from Barrard Inlet, from Alaska, and here below from the Lignitic of the West, with one single leaf referred to *Vaccinium reticulatum*, whose identity is not even positively ascertained. I have seen none in the Pliocene plants of California, and none either in the Miocene of Oregon.

In considering the cause of this peculiar distribution of the *Ericaceæ* in the geological floras of this country, we might find some kind of explanation in the fact, already mentioned by Schimper, that a large number of the fossil species of this order are of doubtful attribution. The absence of plants of the same order in the Tertiary formation of this continent, when compared with the large number of species living at our time, might also be accounted for by their present habitat. They mostly live now in deep woods, especially in sandy soil, along the rocky banks of the hilly torrents, on the top of the mountains, and on the surface of the peat-bogs. Few are found on the borders of marshy ponds or of hollow lakes. *Gaylussacia resinosa*, *Vaccinicum corymbosum*, *Andromeda ligustrina*, and *Clethra Alnifolia* are exceptions; but their leaves are not of a hard consistence, and seem likely to be easily destroyed by maceration. The same remark as the one applied already concerning our limited acquaintance with the fossil floras of this continent and the wide range of probabilities for future discoveries is equally appropriate to this case. Moreover, as the leaves of the *Ericaceæ* are mostly small, they are not likely to come first to view in the explorations.

ANDROMEDA, Linn.

Andromeda Grayana, Heer.

Plate XL, Fig. 4.

Andromeda Grayana, Heer, Fl. Foss. Alask., p. 34, pl. viii, fig. 5; Vancouver u. Brit. Colum. Foss. Pfl., p. 7, pl. i, figs. 7-9.—Lesqx., Annual Report, 1871, p. 298.
Andromeda reticulata?, Lesqx., Annual Report, 1871, p. 298.

Leaves subcoriaceous, lanceolate, narrowed in a curve to the petiole, very entire; lateral nerves at an acute angle of divergence, parallel, camptodrome.

From numerous specimens which I originally referred to this species, the one figured is the more complete. It is like fig. 9 of Heer, with the base more distinctly rounded in narrowing. Other specimens of the same locality

show merely part of the petiole and the base attenuated, as in fig. 6 of Heer (*loc. cit.*). The identification from these fragments cannot be considered as positive.

HABITAT.—Six miles above Spring Cañon, Montana (*Dr. F. V. Hayden*).

Vaccinium reticulatum?, Al. Br.

Plate LIX, Fig. 6.

Vaccinium reticulatum, Heer, Fl. Tert. Helv., iii, p. 10, pl. ci, fig. 30.

Leaves small, subcoriaceous, very entire, oval or obovate, obtuse, narrowed to the base; lateral nerves few, inequidistant.

This leaf has the form and the secondary nervation of those which have been published under this name by Heer. The reticulation is, however, obsolete, and, as it is distinct upon all the specimens figured by the author, the identification of this leaf is uncertain.

HABITAT.—Near Florissant, Colorado (*Prof. E. D. Cope*).

POLYPETALÆ.

UMBELLIFLORÆ.

ARALIACEÆ.

ARALIA, Tournef.

The genus is represented by well-defined and numerous leaves in the Cretaceous of Europe, and especially in that of the Dakota group of North America. Prof. Heer has a species, *A. formosa*, from the Cretaceous of Moletin, and, besides the numerous forms which I originally referred to *Sassafras*, and which are considered by Saporta as rather referable to *Aralia* (three species of which are described in the Annual Report, 1874, as *Aralopsis*), I have, in the same Report, figured four new species of this genus, and one, *A. quinquepartita*, in the Cretaceous Flora, all from specimens of the Dakota group. Two species of *Aralia* are described here from the Upper Lignitic Eocene of the Rocky Mountains. One of them, *A. affinis*, is perhaps only a variety of *A.* (*Platanus*) *nobilis*, from the Miocene of Fort Clarke, Upper Missouri, published by Dr. Newberry, who has also, from the same formation, an *A. triloba*. Higher in the Pliocene of California, three fine species have been found also, all like the former of the section of the palmately lobed leaves of this genus. The Tertiary of Europe has, in its lower divisions, from the Eocene of Sézanne to the Lower Miocene, of France,

the Gypses of Aix, St. Zaccharie, etc., a large number of *Aralia* species, thirty-three of which are described in Paléontologie Végétale by Schimper. But in Europe the genus disappears entirely long before the close of the Miocene. One *Panax* only is found at Oeningen, and the only Miocene *Aralia* is *A. Zaddachi*, Heer, known by a small fragment from the Baltic flora. None has been identified in the Pliocene. This may explain the absence of the genus in the European flora of our epoch; while the predominance of the genus in the Pliocene of the gold-bearing gravel of California may account for the comparatively numerous species of *Aralia* of the present United States flora, which counts six species on the eastern slope and two on the Pacific coast.

The living *Araliaceæ* have been actively studied, and the number of their species considerably increased since the publication of the fourth volume of the Prodromus, where they were described in 1830. Counting those of both *Aralia* and *Sciadophyllum*, thirty-two species only were then known. I am not in position to state what is the distribution of the species of this genus as known from more recent discoveries. The relation, however, of the fossil species of this continent to those of the present flora is satisfactorily established, if not by intimately related characters, at least by succession of types from the Cretaceous until now.

Aralia? gracilis, Lesqx.

Plate XXXIX, Fig. 1.

Liquidambar gracile, Lesqx., Annual Report, 1871, p. 287.

Leaves long-petioled, palmately five-lobed, abruptly narrowed to the petiole; secondary nerves thin, camptodrome, mostly erased.

Considering the close relation of this leaf to those described as *Liquidambar* in the Cretaceous Flora (pl. ii, figs. 1–3, and pl. xxiv, fig. 2), I could but refer it to the same generic division, a reference which, however, has been contradicted, and ascribed to the *Araliaceæ*.* The leaf is somewhat thick, but not coriaceous, divided to above the middle in five lanceolate acute lobes, separated by obtuse sinuses, with the borders very entire, broadly cuneate to the petiole, and the lateral nerves curving quite near the borders, which they follow in successive distinct bows. This species has still the Cretaceous facies and characters. But, as said above, the same type is still preserved in species of the Pliocene of California.

HABITAT.—Bridger's Pass, Wyoming (*Dr. F. V. Hayden*).

* The question is discussed in the Annual Report, 1874, p. 323.

Aralia notata, Lesqx.

Plate XXXIX, Figs. 2–4.

Platanus dubia, Lesqx., Annual Report, 1873, p. 406.*

Leaves subcoriaceous; palmately three- or five-lobed, broadly cuneate or truncate to the petiole; lobes short, ovate, obtuse; secondary nerves close, numerous, camptodrome, united by simple nervilles in right angle to the veins.

The leaves of this species are of large size; for, though it is represented in Dr. Hayden's collection by a large number of specimens, all are mere fragments, the best of which have been figured. Fig. 2 represents a trilobate leaf. This form is not as common as that of the five-lobed leaves, which is recognized by the division of the lower lateral nerves of fig. 4, a division similar to that of the former species (fig. 1). Fig. 3 shows the border side of a large leaf, with the nervilles distinct; other fragments of large lobes represent them, as in fig. 2, short, ovate, obtusely pointed or longer, tapering to an obtuse point, mostly perfectly entire, and then with all the lateral veins close, camptodrome, and straight from the primary nerves to quite near the borders, where they abruptly curve. This species seems very closely allied to *Platanus nobilis*, Newby. (Later Extinct Floras of North America, p. 67); I should not hesitate to consider it as identical, but for the character of the lateral nerves, which are described by the author as straight, and terminating in the teeth of the margin. In this species, the borders are entire and the lateral nerves camptodrome. The difference may be merely casual; for one of the specimens from Troublesome Creek has the close secondary veins camptodrome along the borders of the inner side of the lobes, while on the outer side the borders are obscurely cut by a few small teeth, into which the veins enter as craspedodrome. Other specimens, those of Elk and Yellow Creek, have the characters of *P. nobilis*. Palmately nerved species of fossil *Aralia* have the same variation: *A. primigenia* (De La Harpe), a species from Mount Bolca; the fine *A. Hercules*, Ung.; *Araliopsis mirabilis*, also from the Dakota group, all have the borders of the lobes either entire or dentate, according to the disposition of the lateral veins, and the difference is sometimes observable upon two parts of the same leaf. *Platanus Hercules*, Ung., to which the species described here is closely related, has been recognized by modern authors as an *Aralia* of the section of the *Oreopanax*. It is evidently, like this species, a Cretaceous type, represented in the Dakota group by the leaves originally described as *Liquidambar integrifolium*.

* The specific name had to be changed, as an *Aralia dubia* is described from the European Miocene.

HABITAT.—Mount Brosse, Colorado; leaves with entire lobes (*W. Mitchell*). Elk Creek, near Yellowstone River, Montana (*F. C. Sloane*, *Jos. Savage*). Evanston, Wyoming (*Prof. F. B. Meek*). Yellow Creek and Mount Brosse, Colorado, with *Cissus lobato-crenata*, *Laurus Brossiana*, etc. (*Dr. F. V. Hayden*). Not seen at Golden, Colorado, nor at Black Buttes, Wyoming. It appears to be a northern species, or, at least, widely distributed in the North Lignitic.

AMPELIDEÆ.

In this order, I should perhaps consider merely the North American genera *Vitis* and *Ampelopsis*, the two species of *Cissus* of the present flora being generally described as *Vitis;* and, indeed, both these genera are united in one by the highest authorities. We have, however, some fossil leaves identical with fossil species described as *Cissus* by the European paleontologists, and thus have to follow the distinction which they have established. The *Cissus* species of the present flora are mostly of the tropical and equatorial regions, especially of India, South America, and the Southern Islands. Per contra, the genus *Vitis*, in its limitation, has the greatest number of its living representatives in the United States, which, without counting two of *Cissus*, has eight species of *Vitis*. One inhabits South America; Asia has seven, and Japan two. The origin of the Grape, so widely cultivated in Europe, is apparently unknown. From the historical records of its use, it ought to be placed in Asia. Anyhow, we find the two genera *Cissus* and *Vitis* represented in the European Tertiary, the first by fifteen species, two of which are Eocene, and the second by eleven, which all are Miocene. In this country, we may, it seems, refer the origin of the group to the Cretaceous, for Prof. Heer, in his *Phyllites du Nebraska*, has described as *Cissites* a leaf which he considers as more distinctly representing a species of the *Ampelideæ* than that of any other family of plants; and, from the same formation of the Dakota group, I have referred to the same order nine species, following, for this determination, the opinion of Count Saporta. And as we have, in the Lower Lignitic Eocene, leaves and seeds evidently representing *Cissus* and *Vitis*, this old origin is thus apparently confirmed.

Cissus lævigata, Lesqx.

Plate XL, Figs. 12, 13.

Cissus lævigata, Lesqx., Annual Report, 1872, p. 380.—Schp., Végét. Pal., iii, p. 602.

Leaves membranaceous, with a smooth or polished surface, broadly oval in outline, narrowed in a round curve to the petiole; borders entire.

The two leaves representing this species have the upper part destroyed.

They are apparently cuneate to an obtuse point or obscurely trilobate. Of medium size, three-nerved from the base, they have the secondary veins and their branches running to the borders, and effaced in joining them, and all the nerves thin, though distinct, like the nervilles, which are close, simple, with a net of square or equilateral meshes between them.

Habitat.—Golden, Colorado, where I have found the specimens figured here with other smaller fragments, none of them with the point of the leaf, all identifiable by their membranaceous substance and their reddish, smooth surface.

Cissus Parrotiæfolia, Lesqx.

Plate XL, Figs. 15–17; Plate XLII, Fig. 1.

Cissus Parrotiæfolia, Lesqx., Annual Report, 1874, p. 314.

Leaves ovate, cuneiform to the base, sometimes rounded and subcordate, deltoid to the obtuse point, equally and regularly undulate-crenate, three-nerved from the top of the petiole; lateral nerves divided in parallel, equidistant, straight branches, entering the obtuse divisions of the borders.

The leaves are subcoriaceous, of medium size, averaging eight centimeters long, and five broad a little below the middle, abruptly narrowed or rounded to the petiole. Fig. 16 is a fragment with apparently the same characters, but subcordate to the base. The two lateral primary nerves, as thick as the midrib, and joining it in an acute angle of divergence a little above the basilar border, ascend nearly straight to one of the border divisions, which, a little more prominent than the others, gives to the leaves a slightly trilobed form; these nerves are regularly branched outside, the divisions equidistant, parallel, corresponding to the obtuse, short teeth entered by them. In the figures of pl. xl, the secondary nerves are placed at a great distance above the base; but far less so in fig. 1 of pl. xlii, which I was disposed to consider, by reason of this difference, as a separate species. All the characters of this leaf are, however, exactly the same; the identity of shape is especially striking. I, therefore, admit it as a mere variety. The areolation, distinctly observable in figs. 16 and 17, is, as in the former species, composed of square areolæ, intermediate to strong, mostly simple nervilles.

Habitat.—The specimens of the figures on pl. xl are all from the Lower Green River group, found in connection with *Ficus arenacea*, *F. lanceolata*, *Populus arctica*, etc. The specimen represented in fig. 1 of pl. xlii is from the coal-beds of Medicine Bow, Wyoming, found in connection with *Platanus Guillelmæ* and *Phragmites Œningensis* (*Dr. F. V. Hayden*).

Cissus lobato-crenata, Lesqx.

Plate XLI, Figs. 1-3.

Cissus lobato-crenata, Lesqx., Annual Report, 1872, p. 396; 1873, p. 408.—Schp., Pal. Végét., iii, p. 602.

Leaves subcoriaceous, subcordate at the base, broadly enlarged above it, rapidly narrowed to an obtuse point, crenate and short-lobed all around, three-nerved from the base; primary and secondary nerves branching, all the divisions craspedodrome.

These leaves, of medium size, are all broadly enlarged below the middle, rounded, subcordate or truncate to the petiole, broadly deltoid to the point, with the borders irregularly crenate or lobed, the projections forced out by the primary and secondary nerves being more marked than those of the branches; the secondary nerves, three or four pairs, are distant, opposite or alternate, strong, though not quite as marked as the primary ones; the nervilles thick, joined in a curve in the middle of the areas, simple but united by nervilles in right angle, forming, by subdivision in the same direction, large, irregularly square meshes. This species is related to *C. primæva*, Sap. (Fl. Foss. de Séz., p. 100, pl. x, figs. 10, 11; pl. xi, figs. 1, 2).

HABITAT.—Mount Brosse, Colorado (*Dr. F. V. Hayden*). Not rare at Black Buttes, Wyoming. Not common at Golden, Colorado.

Cissus tricuspidata, Heer.

Plate XLI, Figs. 4-7.

Vitis (*Cissus*) *tricuspidata* Heer, Mioc. Balt. Fl., p. 91, pl. xxviii, figs. 18, 19.—Lesqx., Annual Report, 1872, p. 396.

Leaves small, subcoriaceous, enlarged in the middle or above, indistinctly three- or five-lobed; lobes acute; borders dentate.

The lobes of these leaves, referred to Heer's species, are less distinctly marked than in the specimen of the Baltic Flora; they are shorter, having about the same character as in the former species, being, however, as well as the teeth of the borders, acute, or at least obtusely pointed; the base of the leaves is also, as in the former species, either narrowed to the petiole or truncate-subcordate. Another difference might be pointed out in the distribution of the secondary veins, which, in fig. 19 of Heer's (*loc. cit.*), have the lowest pair emerging at a short distance above the base of the primary nerves. In our figs. 5 and 7, the distance between these veins is considerable; but in fig. 4 it is already reduced, and in fig. 6, which more closely resembles the Baltic leaves, the disposition of the secondary nerves is the same. It is, however, not possible to make a very exact comparison, as Heer's species is represented only by the half of a small leaf, still smaller than that

of our fig. 6, and of course the variable characters, appreciable in other leaves of the same species, may be only hypothetically considered. This species may be a mere variety of the former; the consistence of the leaves being the same, as well as its habitat.

HABITAT.—Black Buttes, Wyoming; not rare.

VITIS, Linn.

Vitis Olriki, Heer.

Plate XLI, Fig. 8.

Vitis Olriki, Heer, Fl. Foss. Arct., p. 120, pl. xlviii, fig. 1.—Lesqx., Supplement to Annual Report, 1871, pp. 10, 12.

Leaf large, cordate, narrowing upward into an angular point; obscurely lobed; borders dentate.

In comparing this leaf with the well-preserved and beautiful one figured by Heer, it is scarcely possible to doubt that both represent the same species. The transverse bar joining the principal lateral veins at the base of the leaf of Greenland is visibly marked in our figure, as also the slight expansion of the lamina of both these leaves at the end of the primary lateral nerves, an extension which shows a tendency to lobes, which upon these leaves are rather by five than by three. The only differences which can be noticed are the less numerous and less distinct teeth of the borders in the American leaves, and also the angular rather than the acuminate point. The somewhat greater distance of the first pair of secondary nerves from the base of the principal ones cannot be counted as a difference, for it is the same between the leaves of the former species, whose nervation is similar.

HABITAT.—Raton Mountains, New Mexico; Evanston, Wyoming (*Dr. F. V. Hayden*).

Vitis sparsa, sp. nov.

Plate LX, Fig. 24.

Seeds cordiform, narrowed to an obtuse point from the enlarged base, seven millimeters long, five millimeters broad, half-round or convex on one side, flattened and ridged in the middle on the other, smooth.

These seeds are larger than those of *Vitis Hookeri*, described by Heer in the Fossil Flora of Bovey Tracy (Phil. Trans., 1862, p. 1070, pl. lxix, figs. 27–29), but of an analogous form, and are evidently referable to *Vitis* or *Cissus*.

HABITAT.—Black Buttes, Wyoming, in connection or rather in the same bank of shaly sandstone, where leaves of *Vitis tricuspidata* are of frequent occurrence.

AMPELOPSIS, Michx.

As this genus is only represented at our time by the beautiful Virginian Creeper, the North American *A. quinquefolia*, Michx., the presence of one species, similar to, if not identical, by the characters of the leaves, with the living one, is a remarkable coincidence, which should not be overlooked in the historical records of the present flora. The geological floras of Europe have not, to this time, any fossil species of this genus.

Ampelopsis tertiaria, Lesqx.

Plate XLIII, Fig. 1.

Ampelopsis tertiaria, Lesqx., Supplement to Annual Report, 1871, p. 7.

Leaf digitate, with five oblong-lanceolate leaflets, gradually narrowed downward to a short, slightly winged petiole, distinctly and distantly serrate; secondary nerves camptodrome, entering the teeth by lateral branches or nervilles.

The nervation of this leaf is similar to that of the leaves of *A. quinquefolia.* The only difference remarked between the fossil and the living species is in the form and size of the leaflets, which in the fossil plant are smaller, narrower, or less distinctly acuminate, and decurring at the base to the short petiole. As in considering a large number of leaves of the Virginian Creeper, it is not very easy to find two of them perfectly similar by the shape of the leaflets, their nervation, and the size of the border teeth, it seems impossible to point out a peculiar character of the fossil species which could not be recognized in some specimens of the living plants.

HABITAT.—Green River, Wyoming, above fish-beds (*Dr. F. V. Hayden*).

CORNEÆ.

CORNUS, Tourn.

In the present flora, this genus is mostly represented by North American species; for nine of these are described in Gray's Flora of the United States, and six in that of California. Half a dozen species are credited to Asia, one to Europe, and one to Mexico. The genus also appears to be of recent origin; for no fragments of leaves referable to *Cornus* have been discovered in any of the Cretaceous formations, either of Europe or of this country. The European paleontologists have described fourteen Tertiary species, one only from the Eocene of Sézanne, all the others Miocene, ranging in their distribution above the 45° of latitude; one found also in Greenland, and another as yet limited to Spitzbergen. In this country, the species described below are from

the Lower Lignitic of Golden and Evanston. One has been described by Dr. Newberry from numerous specimens found in the Lignitic of the Yellowstone River. They are all more or less intimately related to species of our time. The Upper Tertiary or Pliocene of California has two very fine *Cornus*, more closely allied to present species of the Pacific coast. They constitute four per cent. of the whole flora known from that formation, indicating a marked preponderance of the genus in the more recent formations. The leaves of *Cornus* are easily recognized by their ovate, generally acuminate form, and by the direction of the upper lateral veins, curving inside and tending toward the point.

Cornus suborbifera, sp. nov.

Plate XLII, Fig. 2.

Cornus orbifera (Heer), Lesqx., Annual Report, 1873, p. 402.

Leaves oval, rounded upward, and also rounded or truncate to a short petiole, entire; lateral nerves on an open angle of divergence, much curved in traversing the areas; nervilles strong, oblique, with cross-veinlets in right angle, forming loose, irregularly square meshes.

I had considered this leaf as identical with *C. orbifera*, Heer (Fl. Tert. Helv., iii, p. 27, pl. cv, figs. 15–17); but Count Saporta, who has published a leaf of the same species (Ét., iii, p. 97, pl. xiii, fig. 3), has compared ours with European specimens, and considers it different. The lateral veins are not quite as regular in distance in the American leaf, and the nervilles are slightly more oblique. It is, however, difficult to positively note the essential characters of a species from a mere fragment like this; the upper part being destroyed, and the real form being therefore uncertain.

HABITAT.—Golden, Colorado.

Cornus impressa, Lesqx.

Plate XLII, Figs. 3.

Cornus impressa, Lesqx., Annual Report, 1873, p. 408.

Leaves coriaceous, entire, regularly oval, rounded to a very short, scarcely distinct acumen, rounded also in narrowing to the base; secondary nerves at an acute angle of divergence, camptodrome and acrodrome.

This leaf, evidently coriaceous, its outlines being deeply impressed into the stone, is also, but more distantly, related to *C. orbifera*. The secondary nerves, all simple, joined by strong nervilles, more distant and less oblique than in the former species, pass up from the strong midrib in an angle of divergence of about 40°, scarcely curve in traversing the areas, follow the borders by a series of simple bows, anastomosing by the nervilles. The

areolation is obsolete. The upper lateral veins join the middle nerve just under the short acumen. The leaf is of medium size, seven centimeters long and nearly four and a half wide.

HABITAT.—Mount Brosse, Colorado (*Dr. F. V. Hayden*).

Cornus Studeri?, Heer.

Plate XLII, Figs. 4, 5.

Cornus Studeri, Heer, Fl. Tert. Helv., iii, p. 27, pl. cv, figs. 18-21.—Lesqx., Annual Report, 1871, p. 293; 1873, p. 402.

Leaves generally of large size, oval-lanceolate, taper-pointed or acuminate, rounded in narrowing to the petiole; lateral veins simple or sparingly ramified near the borders, and following them in simple bows; fibrillæ distinct, close, in right angle to the nerves, or diverging upward.

From Heer's species, these leaves differ by their still larger size; for, though we have in the collection of the Survey some specimens with fragments of smaller leaves, they are generally larger than those figured from the European Miocene. They differ also by the branching of the nerves quite near the borders, a character rarely seen in leaves of *Cornus*, and not at all marked in Heer's species. By the size and the nervation, the American form has a more marked relation to *C. platyphylla*, Sap. (Foss. Fl. de Séz., p. 103, pl. xi, figs. 8 and 9), which merely differs by more broadly ovate leaves. The affinity is marked also in the great difference of the size of these leaves; for, from the two which are figured, one is as large as our fig. 5, the other only five and a half centimeters long and scarcely two broad. The smallest specimen observed of the American form is six and a half centimeters long. There is also a marked affinity of these leaves to that described as *Artocarpoides conocephaloidea*, Sap., in the same work (p. 356, pl. vi, fig. 6), which has the lateral nerves still more distinctly branched than those figured on our plate. But in these, the upper more distant nerves, evidently tending to the point and acrodrome, as seen in fig. 4, are of the *Cornus* type.

HABITAT.—Evanston, Wyoming. Not rare at Golden, Colorado.

Cornus rhamnifolia, O. Web.

Plate XLII, Fig. 6.

Cornus rhamnifolia, O. Web., Palæont., Separ.-Abdr., p. 78, pl. iv, fig. 8.—Heer, Fl. Tert. Helv., iii, p. 28, pl. cv, figs. 22-25; Mioc. Balt. Fl., p. 41, pl. viii, fig. 4.—Lesqx., Supplement to Annual Report, 1871, p. 9.

Leaf very entire, oval, narrowing up to a short acumen and downward to the petiole; midrib straight; lateral nerves open; nervilles in right angle to the veins.

This leaf seems to differ from the European species when compared to those figured by Heer (*loc. cit.*); for these are broader, with more numerous,

closer, lateral veins, and oblique nervilles; they have, however, as seen in fig. 25, the upper part narrowed to an acumen or to a point. With Weber's figure, our leaf agrees especially in its nervation, the lateral nerves being curved alike in passing toward the borders, and the nervilles, especially distinct in their point of conjunction to the veins, being also in right angle to them, and more distant than in the form described by Heer. The only difference is in the narrower shape of the American leaf, more gradually narrowed to the point, and less obtusely rounded to the base. This leaf is ten centimeters long and four broad; that represented in the Palæontographica is nearly as long and five and a half centimeters broad. Differences of size for leaves of this genus cannot be taken into account for specification.

HABITAT.—Near Point of Rocks, Wyoming* (*Dr. F. V. Hayden*).

NYSSEÆ.

NYSSA, Linn.

A genus exclusively North American at the present time, the only four species known belonging to the flora of the eastern slope of the United States. It is, however, represented in the Miocene of Europe by the fruits of ten species, by the leaves of three others, and by five described as *Nyssidium*, from seeds discovered in the same formation of Spitzbergen. This genus seems to be a recent one, like the former; Prof. Newberry's *Nyssa vetusta* from the Cretaceous being, it seems, recognized by the author as a *Magnolia*. The fruit and leaf described here are both from the Eocene of Golden, and may represent one species only.

Nyssa lanceolata, Lesqx.

Plate XXXV, Figs. 5, 6.

Nyssa lanceolata, Lesqx., Annual Report, 1872, p. 407 (in description of fragments of leaves only).

Leaf broadly lanceolate, rounded in narrowing to the base, with borders very entire; secondary nerves inequidistant, open, parallel, camptodrome; surface punctate. Fruit comparatively large, precisely ovate, round on one side, obtusely pointed on the other, deeply, distantly costate, and striate.

The leaf is of thin, or rather membranaceous, consistence. Its size is seven to eight centimeters in length, the point is broken, and four centimeters broad below the middle; the lateral nerves diverge from the midrib at an angle of 40° to 50°, the two lower pairs being slightly more open, and not as strongly formed as the upper ones, which generally branch once toward the borders, which they closely follow in simple bows. The form and size of

* The Camp Station, near Point of Rocks, has plants of the Washakie group No. 3; that of Point of Rocks Station is much lower, as remarked in the geological part of this work.

this leaf, its nervation and punctate surface, are very much like those of *N. multiflora*, Wang., the common *Tupelo* of the present North American flora.

The fruits, which I refer hypothetically to the same species for the reason that both kinds of organs were found at the same place, and that I did not find until now any other representative of the genus in the specimens procured from the Western Tertiary, are fifteen millimeters long, eight millimeters broad below the middle, marked by regular small costæ, with the intervening space flat, and narrowly lined (as seen in fig. 6, enlarged). For its size, the fruit is comparable to some of the fossil ones described by European authors, especially to *N. maxima*, Web.; *N. arctica*, Heer; *N. ornithobroma*, Ung., etc. The position of these two fruits upon the same specimens seems to indicate them as originally in a cluster.

HABITAT.—Golden, Colorado; rare. Six miles above Spring Cañon, Montana, in small fragments of leaves.

CORNICULACEÆ.

SAXIFRAGEÆ.

CALLICOMA, Andrews.

This genus is exclusively represented in New Holland. This, and the details given below, in the description of these leaves, render the reference of the species to this genus extremely doubtful.

Callicoma microphylla?, Ett.

Plate XLIII, Figs. 2-4.

Callicoma microphylla, Ett., Bil. Fl., iii, p. 5, pl. xl, figs. 14-22.
Rhus? drymeja, Lesqx., Annual Report, 1873, p. 416.

Leaves subcoriaceous, narrowly lanceolate-acuminate, cuneate and inequilateral at the base, short-peticled, with borders sharply and equally dentate, penninerved; secondary veins numerous, straight from the midrib to the point of the teeth.

It is remarked already, in the first description of this species, that its reference to *Rhus* is very doubtful. Since then I have searched carefully for species which might represent the characters of these leaflets, and find them related only with some evidence to this *Callicoma*, originally published from Bilin. Their form, which shows them to be separate leaflets of a compound leaf, prevents their reference to *Myrica*, though they have a marked affinity to *Myrica angustata* and *M. Saportana*, Schp., two species figured and described by Saporta (Ét., iii, p. 125, pl. v, figs. 4-7). The nervation is different from that of any species of *Rhus;* while, except perhaps by the teeth slightly more acute, there is not any difference whatever between these leaflets

and those of the species of Bilin. Their reference to the New Holland genus *Callicoma* is, however, a question that I am unable to consider. The leaflets vary in length from four to five centimeters, with a slender petiole six millimeters long, and a width of five millimeters. The areolation is marked in fig. 4 *a* enlarged.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*). Florissant, near South Park, Colorado (*Prof. E. D. Cope*). The first specimen was procured by *Prof. Allen*, from Elko Station, Nevada. These leaves are, with those of *Planera longifolia*, the more numerous representatives of the upper Green River group.

POLYCARPICÆ.

MAGNOLIACEÆ.

MAGNOLIA, Linn.

This beautiful name is appropriately given to one of the finest orders of the dicotyledonous plants of our globe. The *Magnoliæ* are mostly large trees, some of the species in their full development attaining a height of more than eighty feet. Around Drummond Lake, in the Dismal Swamp of Virginia, one may see *Magnolia* trees bearing immense crowns of green foliage and white blossoms, on branches widely spreading around from the top of smooth, cylindrical trunks, which seem like enormous columns supporting the roof of a temple. The atmosphere, for miles around, is perfumed by the fragrance of their flowers. Indeed, the *Magnolia*, and its relative, the Tulip tree, are wonders of American nature quite as worthy admiration as the great Niagara or the mammoth trees of California. They rival in size the Oak and the Plane, and no other trees have leaves as finely shaped, or flowers like these.

The genus *Magnolia* is at our time North American only. Looking to its history, we find it already in numerous species in the geological floras of Europe and of this continent. It has two species, with very large leaves, in the Cretaceous Flora of Moletin, by Heer. From the same formation of the Dakota group, three have been described, two of which have been seen also in the Cretaceous of Greenland. In Europe, it reappears in the Eocene of Sézanne in one species; in the different strata of the Miocene in nine; and in North America, it is recognized in the Eocene of the Mississippi by five species, some of them seen also in the Lower Lignitic of the Rocky Mountains and described

here. It has not been found until now in the formation of the Upper Lignitic, considered as Miocene; but it has two very fine species, apparently identical with two of our living ones, in the Pliocene of California, an evidence of its general distribution over the whole North American continent before the destructive agency of the Glacial period. As seen from its first representatives, it has remarkably preserved the large size and the essential characters of its leaves.

The seven species of *Magnolia* now living inhabit mostly the Southern States, three only as far up as Southern New York and Pennsylvania. In California, none has been found until now.

Magnolia Lesleyana, Lesqx.

Plate XLIV, Figs. 1–3.

Magnolia Lesleyana, Lesqx., Trans. Am. Phil. Soc., vol. xiii, p. 421, pl. xxi, figs. 1, 2; Supplement to Annual Report, 1871, p. 14; Annual Report, 1873, p. 403.—Schp., Pal. Végét., iii, p. 74.

Leaves large, very entire, obovate-spathulate, enlarged above the middle, gradually narrowed to a short thick petiole, more rapidly attenuated upward to an obtuse point; middle nerve thick; lateral veins distant, strong, camptodrome.

The species prevalent in the lower strata of the Lignitic Eocene, both in Mississippi and Colorado, is distinctly characterized by the shape and the large size of its leaves, of which I have not figured the largest fragments. Their length without the petiole is from fifteen to twenty centimeters, and the width above the middle from six to nine centimeters. Gradually enlarging upward from the base and in an inside curve to above the middle, they are there rounded and contracted upward to an obtuse acumen (fig. 3). This last figure is copied from a specimen of the Mississippi flora; one of the same character has been found later at Golden; the leaf of fig. 2 indicates, by the direction of the upper part of the borders, a similar conformation. The midrib is very thick, often transversely striate by decomposition; the lateral nerves, mostly parallel, preserve from the base the same angle of divergence from the midrib, 50°, passing in a curve toward the borders. The details of areolation are not distinct; only a few of the nervilles, in right angle to the nerves and very thin, are distinguishable (fig. 1). The substance is somewhat thick, but not coriaceous.

HABITAT.—Fischer's Peak, Raton Mountains, New Mexico (*Dr. F. V. Hayden*). Golden, Colorado.

Magnolia tenuinervis, Lesqx.

Plate XLIV, Figs. 5, 6; Plate XLV, Figs. 1–5.

Magnolia tenuinervis, Lesqx., Annual Report, 1869, p. 196.
Magnolia Inglefieldi? (Heer), Lesqx., Annual Report, 1872, p. 396.

Leaves of large size, subcoriaceous, entire, broadly lanceolate, obtusely pointed, rounded to the base; lateral nerves distant, branching irregularly, undulate in passing to the borders, which they closely follow in simple elongated bows.

The midrib of these leaves is not as thick as in the former; the substance of the leaves is somewhat more solid, but not coriaceous; the lateral veins, about on the same angle of divergence, are thick, more irregular in distance, generally undulate, and branching sparingly and irregularly; the top is not contracted, but rather obtusely cuneiform, and, as seen in pl. xlv, figs. 2 and 3, the leaves are not enlarged above the middle, but rather oval-oblong, and rounded to the base, as seen in fig. 3. As all the leaves found of this species are fragmentary, I could not distinctly recognize their basilar outline. The primary areolation, seen in figs. 1 and 3 of the same plate, is composed of large, irregularly square or polygonal meshes, formed by subdivisions, either oblique or in right angle, of the nervilles, which are generally distinct; the ultimate areolation is obsolete. I considered this species as perhaps referable to *M. Inglefieldi*, Heer, of the Arctic Flora, a species represented, like ours, by numerous fragments. The characters of nervation are the same, and the middle part of the leaf is also similar. But the Arctic species has the leaves gradually narrowed to the base, and their substance is coriaceous, the surface polished, etc., characters at variance with those of this one. Fig. 5 of pl. xlv seems different, and its reference seems at first unjustified; but, comparing it with fig. 3, the identity is easily recognized, for the lateral veins are not thicker, but merely deeply carved into the stone, as indicated by the shaded borders. The name of *tenuinervis*, given to this species from the first specimen seen of it, is not quite appropriate, the veins being thin only on the upper surface of the leaves, as in figs. 2, 3, and 4.

HABITAT.—Golden, Colorado, and Black Buttes, Wyoming; not rare. The first specimen (fig. 4) was communicated by *Dr. F. V. Hayden* in 1868 from Golden.

Magnolia Hilgardiana, Lesqx.

Plate XLIV, Fig. 4.

Magnolia Hilgardiana, Lesqx., Trans. Am. Phil. Soc., vol. xiii, p. 421, pl. xx, fig. 1; Supplement to Annual Report, 1871, p. 15.—Schp., Pal. Végét., iii, p. 74.

Leaves large, oblong-oval, rounded in narrowing to the petiole; borders slightly undulate; midrib comparatively narrow; secondary nerves close, parallel, camptodrome.

The fragment figured is far from giving an idea of the fine leaves from

which the species was established. They are at least twenty centimeters long, eight centimeters broad at the middle, oblong-oval, and apparently rounded to an acumen; the point is broken. The essential character recognized in the fragments found at the Raton Mountains and at Golden is the direction of the secondary nerves, which, close, parallel, simple, pass straight upward at an angle of divergence of 50° to 60° from the midrib, and curve near the borders, where they become effaced. This type of nervation is the same in *M. inæqualis*, Sap. (Séz. Fl., p. 107, pl. xi, figs. 4–7).

HABITAT.—Fischer's Peak, Raton Mountains, New Mexico (*Dr. F. V. Hayden*).

Magnolia attenuata, Web.

Plate XLV, Fig. 6.

Magnolia attenuata, Web., Palæont., ii, Separ.-Abdr., p. 78, pl. v, fig. 1.
Terminalia Radobojensis (Ung.), Lesqx., Supplement to Annual Report, 1871, p. 15.

Leaf oblanceolate, gradually narrowed from the middle to the base; lateral veins open, distant, camptodrome.

The relation of this leaf is not positively ascertained, for I have been unable, as Weber also, to find any fragment of its top. The leaf is not coriaceous, but rigid, with borders very entire; the preserved lower part is ten centimeters long, its width where it is broken four and a half centimeters, whence it is gradually narrowed downward to the petiole. The midrib is not thick, but straight; the secondary nerves, on an open angle of divergence of 50°, curving in passing toward the borders, are distant, alternate, mostly simple, but marked by the base of thick nervilles about in right angle, and separated by a few short tertiary veins. In comparing this fragment with Weber's description and figure (*loc. cit.*), I can see no difference, except in the somewhat more open angle of divergence of the secondary nerves in the European leaf.

HABITAT.—Fischer's Peak, Raton Mountains, New Mexico (*Dr. F. V. Hayden*).

ANONACEÆ

ASIMINA, Adans.

Like the former genus, this one is in the present flora limited to the North American continent, and represented by few species. One, *A. triloba*, Dunal, the Papaw, is very common on the bottom-lands of the Middle and Southern States as far south as Florida; three other species are limited in their range to the Southern States; a fifth inhabits Mexico.

In the records of the European fossil floras, no species of *Asimina* is mentioned. They describe, however, nine species of *Anona* from the Miocene. It was, therefore, with some hesitation that I referred to this genus the leaves described here. From the examination of the figures, Saporta considers their attribution to the *Anonaceæ* as legitimate. Numerous species of *Anona* live now in the West India Islands, and in equatorial regions of the continents of Asia and of America. The association of the fossil leaves with those of species of a temperate climate would be a reason for their reference to *Asimina*, even if these characters did not fully agree with those of this genus as now represented.

Asimina Eocenica, Lesqx.

Plate XLIII, Figs. 5-8.

Asimina Eocenica, Lesqx., Annual Report, 1872, p. 387.

Leaves very entire, lanceolate, equally gradually tapering downward to a short, thick petiole and upward to a point; nervation pinnate, camptodrome.

I have seen a large number of specimens of these leaves, varying in size from eight to fifteen centimeters long and from two and a half to four centimeters broad in the middle, where they are the widest, and there oblong, gradually narrowing upward and downward. The consistence of the leaves is somewhat thick, but not coriaceous; the midrib thick, the lateral veins numerous, parallel, all under the same angle of divergence of 50°, slightly curved in traversing the lamina, generally simple or branching once toward the borders, which they follow in a series of bows, formed by anastomoses with veinlets or branches. The nervilles are distinctly marked, at least upon some well-preserved specimens like the one of fig. 8; they are generally joined in the middle of the areas by oblique veinlets, forming large equilateral meshes, the ultimate areolation being indiscernible. These leaves differ especially from our *A. triloba* by their oblong-lanceolate shape, those of the living species being generally enlarged upward, and more distinctly oblong-obovate, and proportionally broader. The nervation, compared in both the small and the large leaves of the living species, fully agrees with that of these fossil leaves, the lateral veins becoming closer and more distinctly marked in the small leaves, as it is in fig. 5. It is the same with the tertiary intermediate nerves, which are scarcely, if ever, distinctly marked upon the small or middle-sized leaves of the Papaw, while they appear, if not numerous, at least perfectly distinct in the large ones. A fruit referable to this genus is

described in the Eocene flora of the Mississippi as *Asimina leiocarpa*, Lesqx. The authority of this determination seems confirmed by these leaves, which, however, are of a higher Tertiary group. They are also related to those of *Anona lignitum*, Ung., and the fruit to that of *A. Altenburgensis*, Ung. (Sillog., i, pp. 25, 26, pl. x, figs. 1–8), both from the Lignitic formations of Germany.

HABITAT.—Carbon, Wyoming; shale under the main coal (*Dr. F. V. Hayden; Prof. F. B. Meek*). I studied it there also in a large number of specimens.

NYMPHEINEÆ.

NELUMBONÆ.

NELUMBIUM, Linn.

Few species of this genus live at our time. They are all remarkable by their large, round, peltate leaves, supported by long stalks, and floating on the surface of ponds or lakes. We have still, in the waters of the Ohio and of the Mississippi Rivers, *N. luteum*, Wild., a species becoming very rare. The leaves are circular, peltate, or borne upon a central petiole, entire, with the nerves placed star-like, numerous, dichotomous in their divisions, and craspedodrome. This generic diagnosis is given here for reference to an anomaly remarked in the nervation of the fossil leaves compared to that of the living ones.

Three species of *Nelumbium* are known in the geological times, and described by European authors.

Nelumbium Lakesii, Lesqx.

Plate XLVI, Figs. 1, 2.

Nelumbium Lakesii, Lesqx., Annual Report, 1873, p. 403.

Leaves thick, subcoriaceous, subcircular, centrally peltate, entire; nerves diverging star-like from the center, simple or scarcely branching on one side only; nervilles strong, joining the nerves in right angle, obliquely dividing in the middle.

These leaves appear to measure about twelve centimeters in diameter; the center is concave, the borders turned down; all the nerves, fourteen, equal in thickness and equally diverging from the center to the circumference, are deeply impressed and thick, sparingly branching, and, as far as can be seen, only on one side, and not by dichotomous divisions; the surface is rough, deeply furrowed by the nervilles at right angle to the nerves, disjointed in the middle by cross-veinlets. It is scarcely possible to see a difference in the size and in the directions of the nerves, which are more or less turned on

one side; none of them either has dichotomous divisions, and thus the leaves of this species seem far different from those of our time, as also from those described from the European Tertiary. In the small leaves of *N. luteum*, the nerves, twice as numerous as in this species, have also a tendency to turn on each side toward the midrib; this character is not remarked upon the fragments of figs. 1 and 2, though it is distinctly so in the better preserved leaf of fig. 3, which I consider as a different species.

HABITAT.—Golden, Colorado (*Rev. Arthur Lakes*).

Nelumbium tenuifolium, Lesqx.

Plate XLVI, Fig. 3.

Nelumbium tenuifolium, Lesqx., Annual Report, 1873, p. 402.

Leaves of a thin texture, comparatively small, eight to nine centimeters in diameter, orbicular, peltate from the middle, with flat, undulate borders; primary nerves thin, equal and equidistant, curved, simple or sparingly branching, crossed at right angle by nervilles, craspedodrome.

The essential differences between this and the former species consist in the thin substance of the tissue of the leaves, the narrower veins, the borders flat, not recurved, the surface smooth or not roughened by the nervation. The number of the nerves, thirteen, instead of fourteen, cannot be considered as of any marked importance. In all the species, either living or fossil, known until now, the primary nerves are dichotomous in their division, a character at variance with that of the nervation of the former species, and which might suggest some doubt in regard to the relation of these leaves to *Nelumbium*. As we do not have in Europe any species of this genus from the Eocene period, we may have here the earliest representative of a new type, whose leaves may not have as yet reached their full development. But even in this fig. 3, we see either simple nerves, or a few branches diverging from the midrib, as in the common nervation of the dicotyledonous leaves, or dividing at the top by an exact dichotomous division, as seen by two of these nerves. Moreover, we have here, on the left side, a straight nerve like a midrib, toward which the lateral veins curve, or rather a back nerve, as in *N. luteum*, in right line with the midrib to the point of which the lateral veins take their direction. In our living species, the two nearest nerves to this back vein often curve, and reach its point by their ends. I do not think, therefore, that the reference of these leaves to *Nelumbium* is contestable. In regard to the possible identity of these three leaves, it could scarcely be admitted. The great difference in their substance seems sufficient to authorize a separate specification, though, in the examination of numerous leaves of *N. luteum*,

I have recognized a variation of the surface, the upper one being more generally smooth than the lower, which also shows the veins somewhat thicker. Even the tissue of the leaves is often hardened by muddy deposits under the floating leaves, and thinner in those raised above water by longer pedicels. These fossil leaves, however, all present the upper surface, as can be seen by the reflexed border of figs. 1 and 2; and the same difference in the characters remarked above, as also in the less number of nerves of this species, are observable upon all the fragments from Golden, and upon the two leaves, of *N. tenuifolium*, one of which only is represented here, and which were obtained from a different locality.

HABITAT.—Sand Creek, Colorado (*Prof. A. Gardner*).

MALVOIDEÆ.

BÜTTNERIACEÆ.

DOMBEYOPSIS, Ung. (emend.).

This genus, as indicated by the termination appended to its name, is still unsettled, and the species referred to it are of uncertain attribution. It would be therefore useless to expose its historical records on mere hypothetical considerations. Five species of *Dombeyopsis* are described from the Miocene of Europe; to some of them, the leaves of our pl. xlvii have a relation more or less defined. Massalongo has briefly described twenty species of the same genus, mostly from the Eocene of Mount Bolca. The photographs from the specimens of three of them have been communicated to European paleobotanists, but I know the leaves merely from the descriptions. Schimper remarks, in Pal. Végét., p. 607, "that evidently, of the numerous *Dombeyopsis* described by Massalongo, some are mere duplicates, or varieties; others are rather referable to *Aralia*, or to analogous genera, than to this *Dombeyopsis*, a genus moreover merely provisionally established." Even Massalongo refers some of them to *Ampelophyllum*, *Grewia*, etc. Saporta considers many of them as representing species of *Tilia*.

Dombeyopsis platanoides, sp. nov.

Plate XLVII, Figs. 1, 2.

Leaves subcoriaceous, very entire, cordate, broadly ovate, subtrilobate, obtuse, abruptly short-pointed; nervation three-palmate; lateral veins equidistant, thick, the lower ones branching outside, craspedodrome with their divisions.

These leaves, of large size, averaging nine centimeters both ways, have

the primary and secondary nerves thick, joined by strong, parallel, arched nervilles, the lateral primary ones sparingly branching, the others mostly simple; they are broadly ovate, enlarged in the middle into two very short, obtuse lobes, and deeply cordate at the base. The relation of the species is marked with *D. lobata*, Ung. (Gen. et Sp., p. 447), published by the same author as *Ficus Dombeyopsis* (Sillog., i, p. 13, pl. v, figs. 1–5), and referred by Schimper to *Sterculia*. The European leaves are longer, more distinctly lobate, and rather palmately five-nerved.

HABITAT.—Above Spring Cañon, near Fort Ellis, Montana (*Wm. Savage*).

Dombeyopsis trivialis, Lesqx.

Plate XLVII, Fig. 3.

Dombeyopsis trivialis, Lesqx., Annual Report, 1872, p. 380; 1873, p. 404.

Leaf comparatively small, deeply cordate, nearly square in outline, three- to five-lobed, obtuse; nervation tripalmate, craspedodrome.

The leaves of this species, smaller than those of the former, still differ by the nervation, being much less deeply marked, all the nerves narrower, and the secondary veins few, placed in the upper part of the leaves, at a great distance from the base. Two lower veinlets, from the top of the petiole, show this leaf as subpeltate and five-palmate. The lobes also, two on each side, are more defined, though obtuse. The substance is not as thick.

HABITAT.—Golden, Colorado.

Dombeyopsis obtusa, Lesqx.

Plate XLVII, Figs. 4, 5.

Dombeyopsis obtusa, Lesqx., Annual Report, 1872, p. 375.

Leaves subcoriaceous, very entire, round-oval, obtuse, cordate; nervation three-palmate.

This species seems closely allied to *D. platanoides*, and may be a variety of it. The primary veins are not quite as thick; the secondary ones are inequidistant, and mostly in the upper part of the leaves, which, as seen from the direction of the lateral primary nerves, which curve inward and are effaced before reaching the borders, are oval, entire, or without lobes. The nervilles, as far as they can be seen (fig. 4), are close and straight.

HABITAT.—Golden, Colorado.

Dombeyopsis grandifolia, Ung.

Plate XLVII, Fig. 6.

Dombeyopsis grandifolia, Ung., Gen. et Sp., p. 447; Foss. Fl. v. Sotzka, pl. xxvi, xxvii, fig. 1.—Goepp., Palæont., ii, p. 278, pl. xxxvi, fig. 2*b*.—Ett., Fl. v. Mont. Prom., p. 21.—Lesqx., Annual Report, 1873, p. 404.

Leaf apparently of large size, deeply cordate or auricled at the base, palmately multinerved.

All the leaves indicated by the above references to European authors

are considered by Schimper as pertaining to the polymorphous *Ficus tiliæfolia*, except that of fig. 1, pl. xxvii, of Unger's Fl. v. Sotzka, which is precisely the one to which this fragment is comparable The same plate of the author has for comparison two leaves of the living *Dombeya cambina*, whose base is deeply cordate, and the six-palmate nervation is of the same type as in the fossil fragments of Unger, to which ours is very similar. This fragment is therefore, like those of the European author, of uncertain relation. The petiole is thick, enlarged, and flattened at its top, where it divides in six equal nerves, diverging star-like, joined by numerous strong nervilles, disconnected and irregular in distance. It seems to have supported a large leaf.

HABITAT.—Golden, South Table Mountain, Colorado.

TILIACEÆ.

Two genera of this order are especially to be considered in regard to their geological relation: *Tilia* and *Grewia*. The first, in the flora of the present epoch, has its distribution limited to Europe and North America, and nearly equally divided in both continents in the small number of its species, four or five in Europe and three in the western slope of the United States. *Grewia* has its numerous species in the equatorial and tropical regions of Asia, especially Java, and of South Africa. A single species, even of doubtful reference to this genus, is credited to this continent, New Granada. Hence, considering this distribution, the presence of species of *Grewia* in the fossil flora of North America would appear somewhat anomalous. Until now, no plant referable to this genus has been seen in the Lignitic formations of the West, but there are some, whose relation is distinctly marked with leaves described by Saporta under his new generic division *Grewiopsis*, which, though its characters are not positively fixed in their relation, has its analogy with the *Tiliaceæ* of our time. Of *Tilia*, I have not found any evident representative in the Lignitic; but Dr. Newberry has described *T. antiqua* from the Miocene of Fort Clarke, and Heer has one also, *T. Alaskana*, from the same formation of Alaska. From the Tertiary of Europe, the authors have described seven species of *Tilia* from leaves and two from seeds. They have also six species referred to *Grewia*, and seven species of *Apeibopsis*, which apparently represent *Apeiba*, a genus of this order, which now has half a dozen species, all limited to tropical America, Guiana, etc.

GREWIOPSIS, Sap.

Leaves of various forms, often large and diversely lobed, generally acutely denticulate, more or less cordate, subpalmately nerved; lateral primary nerves more prolonged than the secondary ones, branching outside, with branches craspedodrome, like the secondary nerves, which are often unequal in length, and joined by intermediate veins in various directions; tertiary nerves transverse, veinlets united by nervilles in quadrate or trapeziform meshes.

In the comparison of the following species to some of those which the author has described as referable to it, it will be seen that the generic characters are not yet definitely fixed.

Grewiopsis Saportana, sp. nov.

Plate L, Figs. 10–12.

Aleurites Eocenica, Lesqx., Annual Report, 1872, p. 397.

Leaves membranaceous, somewhat thick, oval, obtusely pointed, cuneate to the petiole, distantly, minutely denticulate; subpalmately nerved, all the divisions craspedodrome.

The three specimens here represented of this species are all of the same size, averaging eight centimeters long and four and a half centimeters broad. Their form does not agree well with the characters indicated in the generic diagnosis, the base being cuneiform or rapidly narrowed, but not cordate. The same character is, however, exactly similar in the leaves of *G. orbiculata*, Sap. (Séz. Foss. Fl., p. 411, pl. xi, figs. 11, 12), to which this species is intimately related. Indeed, in comparing both figs. 10 and 11 of our plate with fig. 12 of the Sézanne Flora, the only difference worth remarking is in the smaller size of the European leaves. The subpalmate division is somewhat more indistinct in the American species, but fig. 13 of the Sézanne Flora shows it quite as indistinctly as our fig. 11. I have therefore no doubt whatever about the reference of the leaves of Black Buttes to the same genus as the one which has been established for the description of those of the Eocene of Sézanne; even the petiole seems to have been long in the European leaves, as seen by the fragment left of it (fig. 12, *loc. cit.*), and in that of *G. tremulæfolia* of the same flora. When I referred these leaves to *Aleurites*, the flora of Sézanne was not published, and the leaves of some species of this genus inhabiting Cuba seemed to be the only ones to which the fossil remains figured here had some apparent relation. There is, however, a marked difference in the tertiary and the secondary nervation, the tertiary nerves curving nearer to the borders in *Aleurites triloba*, Gray, to which I compared the fossil leaves, and especially in the irregular direction of the nervilles, which are more distinctly marked, and the border veinlets as strong as tertiary veins. The specific name had to be changed, of course, as inappropriate, as all the species of *Grewiopsis* known

until now are Eocene. The primary netting is, as described in the diagnosis of the genus, in quadrate or trapeziform meshes; the ultimate areolation, as seen in fig. 12, consists in small irregularly quadrate cells. Two of the leaves (figs. 10 and 12) are nearly entire; in fig. 12, however, the lateral nerves and their branches are extended to the borders, forcing them out here and there, and proving a disposition to the same kind of divisions as in fig. 11. The same character of a more or less distinct denticulation is seen also in the species of the Sézanne Flora (*loc. cit.*).

HABITAT.—Black Buttes, Wyoming; not common.

Grewiopsis tenuifolia, sp. nov.

Plate XL, Fig. 14.

Leaves membranaceous, rounded or cordate, taper-pointed, subpalmately nerved; borders irregularly dentate; lateral nerves mostly craspedodrome or entering the teeth by strong nervilles.

This species, though represented by a single fragment, seems different from the former, to which it was originally united. The tripalmate nervation is more distinctly marked by the prolongation of the lower lateral veins into more prominent teeth, giving to the leaf a slightly trilobate form. The secondary nerves are more distant, less numerous, three or four pairs only, while in the former species the number is generally double. The consistence of the leaf is also different. It is rather thin, membranaceous, of a reddish color, and all the veins are thin, though quite distinct to the eyes, as well as the veinlets, which are of the same character as in both the former and the following species. Its relation is with *G. anisomera*, Sap. (Fl. Foss. de Séz., p. 409, pl. xiii, figs. 8, 9), whose nervation is subpalmate and the leaves of much larger size than ours, and more still with *G. sidæfolia*, Sap., as represented in the text (p. 407) of the same work, a figure which exemplifies the nervation, nearly exactly as it is in our species. But the nerves are thick in the European species, and the fragment indicates a larger leaf. The author remarks, however, that the nerves are prominent underneath; but that in the upper surface they are merely defined or obsolete. But for the larger size of the leaves, therefore, the characters are alike.

HABITAT.—Black Buttes, Wyoming; with the former.

Grewiopsis Cleburni, Lesqx.

Plate LXII, Fig. 12.

Grewiopsis Cleburni, Lesqx., Annual Report, 1874, p. 306.

Leaves rather small, subcoriaceous, ovate, rounded and narrowed by an inward curve to the petiole, sinuate-denticulate, palmately three-nerved from a distance above the base; primary nerves thick; secondary veins two or three pairs, distant, all branching outside, with subdivisions or veinlets entering the teeth; nervilles at right angle to the veins, flexuous, simple or obliquely dividing in the middle; areolation obsolete.

This leaf, about five centimeters long (the point is broken), four centimeters broad in its widest part, below the middle, is remarkably similar to the two figures given by Saporta (*loc. cit.*) of his *G. orbiculata;* it is only somewhat larger, its border denticulation more distinctly marked, though exactly of the same character, and its base is curved inside in narrowing to the petiole, and abruptly descending to it, or nearly decurrent, and not rounded. These differences are, however, of so little moment, that, if this fragment had been found at Sézanne, it could but have been considered as identical with that of *G. orbiculata.* This close analogy, like that of other leaves described from Black Buttes and Point of Rocks, all the species figured in pl. lxii for example, evinces the relation of the Lower Lignitic of Wyoming and Colorado to the Eocene of Europe.

HABITAT.—Point of Rocks, Wyoming (*Wm. Cleburn*).

APEIBOPSIS, Heer.

This genus is known mostly by *large capsular fruits, five- to sixteen-valvate, furrowed, bearing small round seeds, biseriate in each cell.* The leaves of one species only are known, and described as *palmi-nerved, with the midrib stronger and the lateral veins camptodrome*

Apeibopsis? discolor, Lesqx.

Plate XLVI, Figs. 4–7.

Rhamnus discolor, Lesqx., Annual Report, 1872, p. 398.

Leaves membranaceous, truncate, or subcordate, ovate, acute, entire, long-petioled; midrib thick; lower secondary veins opposite, all parallel, equidistant, joined by oblique simple nervilles.

The numerous specimens which I have collected and studied at Black Buttes are mostly fragmentary, but represent leaves of about the same size, six to seven centimeters long, and four to five and a half broad toward the base. They are all easily identified by the yellowish color of the lamina, which is rather membranaceous, and the black color of the lateral nerves. In some specimens, as in fig. 4, where the base of the leaf is more evidently cordate, the nervation is subpalmate; but in others, like that of fig. 6, the

secondary nerves are all equal in size, in direction, in distance, etc., and the leaves pinnately nerved. The average divergence of the lateral veins is 60°; they all curve more or less in traversing the areas, forming regular simple festoons along the borders, and joined by nervilles about in right angle and mostly simple. I have not been able to find any distinct traces of areolation. I cannot compare these leaves to living species of *Apeiba;* but they have such a degree of similarity by their form and characters to those of *Apeibopsis Deloesi*, Heer (Fl. Tert. Helv., iii, p. 41, pl cix, figs. 9–11), that the generic relation seems evident. That these leaves, however, are referable to *Apeiba* is not certain. I considered them at first as *Ficus*, then as *Rhamnus*, and, indeed, their relation to *Ficus*, especially by the nervation and the long petiole, which in fig. 5 is four and a half centimeters long, is distinctly marked, but contradicted also by the size of the petiole, equal to that of the midrib, or proportionate to it and not inflated.

HABITAT.—Black Buttes, Wyoming. Though the leaves are there abundant enough in the sandy shale above the main coal, I have never found any fruit comparable to those published under this generic name by European authors

ACERINEÆ.

ACERACEÆ.

ACER, Linn.

About thirty species of Maple are known in the flora of our time, all inhabiting the temperate regions of the northern hemisphere, especially Europe, North America, and Japan, where they are distributed in about the same proportion. Europe has ten species; nine belong to the United States. The European Tertiary formations have furnished to paleo-botanists a large number of species, forty-six of which are described and recognized as referable to the different types of this genus, besides fifteen of uncertain attribution. From this we should expect to see it equally well represented in the American Lignitic. It is, however, not the case, for the species described here, and another from Alaska by Heer, are as yet the only ones from the Miocene of this continent. The origin of the *Aceraceæ* appears to be recent. Dr. Newberry has described as *Acer pristinus* a leaf from the Cretaceous of the Dakota group. The specimen which I have seen at the Smithsonian Institution is very fragmentary, but evidently referable to the species which I have considered, from more complete specimens, as a *Liquidambar* (Cret.

Fl., p. 56, pl. ii, figs. 1–3; pl. xxiv, fig. 2; pl. xxix, fig. 8), and which, according to European authors, might rather represent some kind of *Aralia*. In the same work, I have described as *Negundoides* a fragment of a leaf whose attribution is very doubtful; and from the Cretaceous of Niedershoena, d'Ettingshausen has an *Acer antiquus*, which he considers himself as of uncertain generic reference. Hence we have no positive evidence of the presence of *Acer*, nor of any *Aceraceæ*, in the Cretaceous; and the absence of plants of this order in the Eocene of Europe and of America confirms the non-existence of this group in the Cretaceous and the Lower Tertiary. The oldest representative of *Acer* appears in the Armissan of France, where it is extremely rare; the genus becomes more predominant in the Lower Miocene, and has its largest preponderance in the Middle and Upper Miocene. In North America, as remarked above, we know only two Miocene species, one from Carbon, the other from Alaska. Other kinds of *Aceraceæ*, *Sapindus* and *Negundo*, have also representatives in the same formation. They become, however, more numerous in more recent stages of the Tertiary; for the Upper Green River group abounds in leaves of *Sapindus;* it has, besides, one species of *Acer*, identified in the Pliocene of California, which has two kinds of Maple leaves in the fifty species known from this group. It is very probable that *Acer* will be found amply represented in the Pliocene of the Mississippi River.

Acer trilobatum var. **productum?**, Al. Br.

Plate XLVIII, Figs. 2, 3*a*.

Acer trilobatum, Al. Br., N. Jahrb. v. Bronn & Leonh., 1845, p. 172.—Ung., Chlor. Protog., p. 130, pl. xli, figs. 1–8.—Heer, Fl. Tert. Helv., i, p. 48, pl. ii, figs. 3, 4, 6, 8; iii, p. 47, pl. cx, figs. 16–21; cxi, figs. 1, 2, 5–14, 16, 18–21; cxii, figs. 1–8, 11–16; cxiii; cxiv; cxv; cxvi, figs. 1–3; p. 197, pl. clv, figs. 9, 10.—Ung., Foss. Fl. v. Kumi, p. 49, pl. xii, figs. 28–30.—Sap., Ét., iii, p. 101.—Ludw., Palæont., viii, p. 127, pl. l, figs. 1–5; li, figs. 4–11; lii, figs. 2, 4–7; liii, fig. 6.—O. Web., Paleont., ii, p. 195.—Ett., Foss. Fl. v. Bil., iii, p. 18, pl. i, fig. 14; xliv, figs. 1–5, 7–9, 12–15.—Lesqx., Annual Report, 1872, p. 388; 1873, p. 408.

Phyllites trilobatus, Sternb., Fl. d. Urw., i, p. 42, pl. l, fig. 2.

Phyllites lobatus, Sternb., *ibid.*, p. 39, pl. xxxv, fig. 2.

Acer tricuspidatum, Al. Br., *l. c.*, p. 172.

Acer patens, Al. Br., Stizenb. Verz., p. 84.

Acer productum, Al. Br., N. Jahrb., *l. c.*, p. 172.—Ung., Chlor. Protog., p. 131, pl. xli, figs. 1–9; Stizenb. Verz., p. 84.

Acer vitifolium, Ung., Chlor. Protog., p. 133, pl. xliii, fig. 10?.

Acer megalopterix, Ung., Sillog., iii, p. 47, pl. xv, fig. 6.

Accrites filicifolius, Viv., Mém. Soc. Géol. de Fr., 1833, i, p. 131, pl. ix, fig. 5?.

Accrites deperditus, Mass., Fl. Foss. d'Ital. Mer., p. 4, pl. ii, fig. 7.

Liquidambar Scarabellianum et L. affine, Mass., Fl. Foss. Senog., pl. ii, fig. 1; pl. iii, fig. 5.

Platanus cuneifolia, Goepp., Schoss. Fl., pl. xii, fig. 1.

Leaf comparatively large, deeply trilobate, narrowed to a long petiole; lobes sharply acuminate, the middle twice as long as the lateral ones; borders dentate. Fruits small; nutlets obovate; wings oblong, obtuse.

The characters of this leaf, the only one satisfactorily preserved from

many specimens observed at the same locality, are somewhat different from those which have been referred to this species by European authors, and of which numerous specimens have been figured; for it is one of the species the most commonly found in the Middle Miocene of Switzerland, Germany, and Italy. It differs especially by the more acuminate and more oblique lateral lobes, and by the more equal and shorter teeth. There are, however, corresponding forms for the length and obliquity of the lobes represented in Heer for example (*loc. cit.*, pl. cxii, figs. 6, 7), this last, a leaf with borders equally and short dentate, as they are seen in fig. 2 of our plate. *A. trilobatum-productum* in pl. cxiv, fig. 8, and pl. cxv, figs. 8, 11, of the same author, has the leaves with the narrowed base and the prolonged middle lobe, the borders, however, more deeply and irregularly dentate; and Ludwig also (*loc. cit.*, pl. l, fig. 3) represents a leaf of an analogous form, but which has at its base two lateral veins, wanting in that of our fig. 2, which is exactly three-nerved, like most of those referred by Heer to this variety. I am, therefore, disposed to consider the specimen from Carbon as referable to the same species. I have, moreover, seen fragments with a more definite denticulation, and all were found at the same locality. The seeds also (fig. 2 *a*) are different, especially by the small size of the wings, directed straight upward, and of the nutlet, rather truncate at the point of insertion of the wings, from those which have been referred to this species by European authors. The only fruit of *Acer*, however, corresponding in characters with those which are figured upon our plate, is that in Heer (*loc. cit.*, fig. 16 *b*), the upper one of the same size as ours, the wing scarcely more inclined, and the lower one larger, but both considered by the celebrated author as fruits of *A. trilobatum*. Further researches at Carbon, where the fragments of leaves of *Acer* are not rare, may result in the discovery of specimens more definite in characters as evidence of their specific relations.

HABITAT.—Carbon, Wyoming.

Acer æquidentatum, Lesqx. (ined.).

Plate XLVIII, Figs. 1, 3.

Leaves small, trilobate, and palmately three-nerved; lateral lobes short, oblique, acute; borders equally distantly denticulate.

Some well-preserved leaves have been described under this name in the Flora of the Gold Gravels of California, which is not yet published, and I consider these figured here as referable to the same species. These leaves

are small, the largest seen measuring eight centimeters between the points of the lateral lobes, and the same from the top of the long slender petiole to the point of the middle. Their consistence, though somewhat thick, is not coriaceous; they are generally rounded or truncate to the petiole, and marked all around the borders by short equal teeth, generally turning upward; the lateral lobes are short, acute, or with a short acumen, all diverging 30° to 40° from the midrib, and half as long as the middle. The relation of these leaves is with *Acer vitifolium*, Al. Br., a very rare species of Oeningen, not yet satisfactorily known and characterized. Comparable also with those figured as *A. trilobatum* by Ludwig (*loc. cit.*, pl. lii, figs. 4–6), they differ essentially by shorter, broader lobes. From the species as represented by California specimens, this one differs also somewhat by the less distant, smaller, less acute teeth, and thus seems a transitional form between the Pliocene species and the European Miocene *A. trilobatum*. Fig. 3 of our plate is merely a longer, more tapering, middle lobe. It was found with a third incomplete fragment of another leaf, like fig. 1, at the same locality of the Green River group, a formation intermediate between the Carbon Miocene and the Gold Gravel Pliocene.

HABITAT.—Near the confluence of White and Green Rivers, Utah, with *Planera longifolia*, *Sapindus Dentoni*, *Myrica acuminata*, etc. (*Prof. Wm. Denton*).

SAPINDACEÆ.

SAPINDUS, Linn.

The genus has in the present flora few species, most of them distributed over the tropical regions of the globe. One species still inhabits the Southern United States. The geological records refer the origin of the genus to an older period than that of *Acer;* at least, one of our species is described from the Eocene of Golden and Black Buttes. It is there extremely rare. From Carbon group, we have one also. It is abundantly represented in the Green River group, not only by comparatively numerous forms, but by a profusion of specimens. Prof. Newberry has described two species of *Sapindus* from the Miocene of Fort Union and of the Yellowstone Lignitic. In Europe, twenty-one species of this genus are known, all Miocene, except a very rare one described by Saporta from the Armissan. Its absence from the Pliocene of California may explain its nearly total disappearance from the present flora of North America.

Sapindus caudatus, Lesqx.

Plate XLVIII, Fig. 6.

Sapindus caudatus, Lesqx., Annual Report, 1872, pp. 380, 397.

Leaflets somewhat thick and membranaceous, sessile, very entire, inequilateral, rounded to the base, oval-oblong, abruptly narrowed into a long, sharply pointed acumen.

The leaf is comparatively large, eleven centimeters long, four and a half centimeters broad, one of the sides measuring two centimeters; for, like all our fossil species, it is inequilateral, entire, and with a pinnate, camptodrome nervation. By its form and nervation, it resembles *S. falcifolius*, Al. Br. in Heer, Fl. Tert. Helv., p. 61, pl. cxix, the areolation being of the same character as in fig. 1 *b*. But the leaflet was evidently sessile, like those of *S. densifolius* of the same work (pl. cxx), and it differs from both by its scarcely falcate outline, its broader size, and its long, narrow acumen.

HABITAT.—Golden, Colorado, and Black Buttes, Wyoming.

Sapindus stellariæfolius, sp. nov.

Plate XLIX, Fig. 1.

Sapindus angustifolius, Lesqx., Annual Report, 1873, p. 415.

Leaves small, linear, impari pinnate; leaflets mostly alternate, lanceolate, acuminate, rounded in narrowing to a sessile base; nervation obsolete.

The branch (fig. 1) seems to represent a fascicle of leaves not yet fully developed. Its connection with the leaflet (fig. 2) upon the same specimen, and also the size of that of fig. 3, which is intermediate, seemed to authorize the reference of the branches and leaflet to the same species. I have, however, received lately, from a different locality, a specimen which contradicts this reference. It represents one branch bearing leaflets, and some detached ones of the same characters and size as those of fig. 1. The branch is fully developed; the rachis, flattened by compression, somewhat broader; the leaflets are sessile, in odd number, and no remains of the following species are mixed with them. The characters are moreover somewhat different from those of *S. angustifolius;* the leaflets, sessile, without prolongation of the narrowed base, are thin, nearly equilateral, and therefore I now consider this union of the leaflets of two species closely allied in characters as casual. The leaflets of this species are largest nearer their base, and more abruptly rounded to the point of attachment; the point is more acute and less prolonged.

HABITAT.—Near Florissant, South Park, Colorado (*Prof. E. D. Cope*). Near Castello's Ranch, Colorado (*Prof. W. A. Brownell*).

Sapindus angustifolius, Lesqx.

Plate XLIX, Figs. 2–7.

Sapindus angustifolius, Lesqx., Annual Report, 1873, p. 415.

Leaves impari-pinnate; leaflets slightly membranaceous, lanceolate, acuminate, very entire, sessile or attached to the rachis by a narrowed, winged base.

The species is represented in numerous specimens by leaflets varying in size from two and a half to nine centimeters long, lanceolate or linear-lanceolate, gradually acuminate, inequilateral, but not falcate, sometimes merely slightly curved at the point, enlarged in the upper side, and narrowed to a sessile base, which is generally prolonged into a short, winged petiole. The rachis is flat, not winged. The nervation and areolation are of the same type as figured by Heer for *S. falcifolius* (Fl. Tert. Helv., iii, pl. cxix, fig. 1 *b*), a species to which this one is closely allied, especially differing by the smaller size of its sessile leaves.

HABITAT.—Castello's Ranch, Colorado (*Prof. E. D. Cope*). Middle Park, near Florissant, Colorado (*Dr. F. V. Hayden*).

Sapindus coriaceus, Lesqx.

Plate XLIX, Figs. 12–14.

Sapindus coriaceus, Lesqx., Annual Report, 1873, p. 415.

Leaflets hard, coriaceous, oblong-lanceolate, very entire, more or less distinctly inequilateral, short-petioled; borders reflexed; middle nerve thick; lateral veins scarcely discernible; surface polished.

These fragments of leaflets have about the same form as those of the former species, but are easily identified by their hard, leathery texture, and the distinct, though short petiole. They are generally larger, and appear gradually narrowed to a short acumen. All the specimens are broken, and none represent the upper part of a leaflet. The rachis also has not been observed. The lateral veins are scarcely discernible through the texture of the leaves. All that could be seen of them is figured.

HABITAT.—Elko Station, Nevada (*Prof. E. D. Cope*), in connection with *Planera longifolia*, *Sequoia angustifolia*, *Taxodium dubium*, etc.

Sapindus Dentoni, Lesqx.

Plate LXIV, Figs. 2–4.

Sapindus Dentoni, Lesqx., Annual Report, 1874, p. 315.

Leaflets with entire or slightly undulate borders, lanceolate, gradually tapering to a long acumen, rounded to the base and narrowed to a short petiole; lateral nerves close, parallel, nearly straight to the borders, where they abruptly curve.

By the shape and the size of the leaflets, this species is related to *S.*

angustifolius described above, and still more, on account of the petiole, to *S. falcifolius*, Heer (*loc. cit.*), greatly differing from both by its close, numerous, straight lateral nerves, which curve so abruptly near the borders, and follow them so closely, that they seem as entering them. The borders of the leaflets are, however, more or less reflexed, and, when flattened, the successive bows of the veins are distinctly seen. The areolation is the same as in *S falcifolius.* The substance of the leaves is somewhat more consistent than in *S. angustifolius*, but not coriaceous.

HABITAT.—Upper Green River group, near the mouth of White River, Utah (*Prof. W. Denton*).

Sapindus obtusifolius, Lesqx.

Plate XLIX, Figs. 8–11.

Sapindus obtusifolius, Lesqx., Annual Report, 1873, p. 419.

Leaves impari-pinnate; rachis flat, not winged; leaflets sessile, ovate, obtuse or obtusely pointed, narrowed in a curve to the base, very entire; lateral veins inequidistant, curving in traversing the laminas; nervilles in right angle, distinct.

The leaflets are extremely variable in size; from one and a half to nine, even ten, centimeters long; for I have fragments indicating fully this size, being generally half as broad as they are long. This indicates a large number of leaflets for the leaves. The leaflets are about exactly ovate, more or less obtuse, and also enlarged in the upper part in diverse proportion, some of them being nearly equilateral. The consistence is subcoriaceous, the surface smooth, undulate, sometimes polished. The lateral veins, on a broad angle of divergence curved in passing to the borders, follow them at a short distance in simple series of bows, casually displaced by the interposition of tertiary, shorter veins, anastomosing to the upper part of the lateral nerves. The nervilles, in right angle to the nerves, are generally distinct, but the areolation is always obsolete. This species has apparently a distant relation to *S. membranaceus*, Newby. (Ext. Fl., p. 52), but none whatever to any of the European fossil congeners.

HABITAT.—Eight miles southeast of Green River Station, Wyoming, in connection with thin beds of coal referable to the Washakie or Carbon group. A bed of shale is at this locality filled with leaflets of this species mixed with fragments of leaves and branches of *Musophyllum*. I could find there no other species. *Mr. Wm. Cleburn*, who visited later the same locality, has, among numerous specimens of these two species, one fragment of *Carpinus grandis*.

FRANGULACEÆ.

STAPHYLEACEÆ.

STAPHYLEA, Linn.

On this genus, the Flora of California remarks that its five living species are native of as many regions in the northern temperate zone, viz: Europe, the Himalayas, Japan, California, and the Atlantic States. De Candolle, in the Prodromus, refers one species to Peru. None have been recognized in the European Tertiary.

Staphylea acuminata, Lesqx.

Plate XLVIII, Figs. 4, 5.

Staphylea acuminata, Lesqx., Annual Report, 1873, p. 415.

Leaves trifoliate from the enlarged top of an elongated common pedicel; leaflets ovate, lanceolate, acuminate, rounded at the base to a short petiolule, serrulate; terminal leaflet longer-acuminate, and longer-petioled; nervation pinnate and camptodrome.

The species is remarkably similar, considering the leaves at least, to the North American *S. trifoliata*, Linn.; the leaflets being merely comparatively narrower and longer, and the middle one shorter-petiolulate. The nervation is of the same character; the lateral veins, more distant in the upper part, curve in passing toward the borders in an open angle of divergence, following them in successive bows, with nervilles entering the teeth; the areolation, as far as it can be recognized in fig. 5, is formed by the irregular divisions of nervilles at right angle. There is no great difference in the size of the leaflets, the middle one eight and a half centimeters long, the lateral ones eight, with an average width, for both, of three and a half to four centimeters. The substance of the leaves is apparently membranaceous, somewhat thicker or more rigid than in the living species. The teeth of the borders are about of the same size, though they do not appear so directly curved inside. I have received from South Park, near Castello's Ranch, a specimen which seems to represent the same species, with the three leaflets folded, the two sides upon another along the midrib. They are slightly longer, and the border denticulation is scarcely marked. The secondary nerves only are somewhat distinct, and, from this imperfect state of preservation, the identification is not reliable.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*). Castello's Ranch, Colorado, in a more obsolete specimen (*Prof. W. A. Brownell*).

CELASTREÆ.

CELASTRUS, Linn.

A large number of species of this genus, more than sixty, are described in the present flora. Half of them are credited to Africa, especially to the Cape of Good Hope. India and China, with Japan, have fifteen species, and North America one. A few inhabit Peru and South America. It is remarkable that in Europe, where the genus is not represented by any species at our time, the Tertiary flora has such a large number of *Celastrus*, fifty-four species, mostly distributed in the Lower Miocene (Armissan, Ligurian, etc.). Besides these, four species of *Celastrinites*, a genus established by Saporta, are described from Sézanne, and three as *Celastrophyllum*, from Bilin, by d'Ettingshausen. Leaves referable to these divisions are, per contra, extremely rare in our Tertiary. From the Cretaceous of the Dakota group, I have described, as *Celastrophyllum ensifolium* (Cret. Fl., p. 108, pl. xxi, figs. 2, 3), leaves which, in the opinion of European authors, of Count Saporta especially, are referable to the order of the *Celastreæ*, and related indeed to a *Celastrophyllum* recognized in the Cretaceous of Niedershoena by d'Ettingshausen. And, until now, from the American Tertiary Lignitic, we have only two kinds of leaves apparently referable to this order, both described here as *Celastrinites*. This case, with some others recorded already, shows the great difference in the flora of the North American Tertiary compared with that of Europe. In the groups of plants predominant in our present flora, the analogy of distribution at the Tertiary epoch upon both continents is sometimes remarkable. In those which are now exotic, especially the Austro-Indian, African, and Australian types, the differences are wonderful indeed.

Celastrinites artocarpidioides, Lesqx.

Plate XXXV, Fig. 3.

Artocarpidium olmediæfolium?, (Ung.) Lesqx., Annual Report, 1873, p. 400.

Leaf ovate-elliptical, apparently obtuse, cuneate to the petiole, borders irregularly distinctly crenate; secondary nerves inequidistant, open, mostly simple, curving at a distance from the borders.

This leaf appears rather thin, has its surface crumpled, and the nervation somewhat indistinct. It is comparatively small, seven centimeters long and four wide, and apparently obtusely pointed (point broken); the base is cuneiform to a short petiole, also destroyed in part; the border cut in irregular, obtuse or pointed teeth, and the nervation camptodrome, the sec-

ondary nerves curving at a distance from the borders, and forming a double series of bows by anastomosis of the nervilles. The characters of the nervation are the same as in *Celastrus cassinefolius*, Ung., figured by Heer (Fl. Tert. Helv., iii, pl. cxxi, figs. 24–26), but our leaf is twice as large as those represented by the European authors. I have been a long time in doubt, and am still uncertain, of the true relation of this and the following species.

HABITAT.—Golden, Colorado (*Rev. A. Lakes*).

Celastrinites lævigatus, sp. nov.

Plate XVII, Figs. 16, 16 *a*.

Myrica ambigua, Lesqx., Annual Report, 1871, p. 297.

Leaves hard, subcoriaceous, with a smooth or polished surface, apparently long, linear or oblong, with borders distantly denticulate; secondary nerves in right angle, branching from the middle, each with one or two intermediate, parallel, tertiary veins.

Nothing has been seen in relation to this species but the fragments figured, which represent the lower part of somewhat large leaves. They greatly resemble part of leaves of *Banksia* and *Dryandroides*, mostly now considered as *Myrica*, like *D. Banksiæfolia*, Ung., *D. lævigata*, Sap., *D. lignitum*, etc., as may be seen by the numerous figures representing these species in Heer (Fl. Tert. Helv., ii, pl. xcix, figs. 4–16). The character of nervation presents a notable difference; for, in this American form, the secondary veins do not pass on to near the borders but anastomose in the middle of the lamina by nervilles joining them to branchlets, either of the tertiary or of the upper secondary nerves, and, by their subdivisions, they form along the borders a double or triple range of festoons. This character indicates their relation to the *Celastreæ*, and is marked indeed in some of the species of *Celastrinites* described by Saporta in the Sézanne Flora, especially in *C. legitimus* and *C. venulosus*, as represented in pl. xv, figs. 11, 12, and 13. I followed the opinion of this celebrated paleontologist in referring these fragments, like the former, to this genus.

HABITAT.—Six miles above Spring Cañon, top of the hills, between Fort Ellis and Bottler's Ranch, Montana (*Dr. F. V. Hayden*).

ILICEÆ.

ILEX, Linn.

In the records of the plants of the present epoch, we find about twenty-five species of *Ilex* satisfactorily described, mostly referred to North and

South America, and a few to Madeira and Asia. Ten species belong to the United States; none to California, however. The ancient history of the genus is followed in Europe from the Upper Cretaceous of the Gypses of Aix, through the Armissan, to the Miocene and the Pliocene, where, in the small group of plants of Maximieux, we find one species which the authors compare to *I. Balearica*, Desf., and *I. Canariensis*, Poir. One species only has been left in the flora of Europe. As yet, the few fossil species which we have observed in the Western Tertiary of Colorado are from specimens of the Green River group and of the Parks, considered as Upper Miocene.

Ilex Vyomingiana, sp. nov.

Plate L, Fig. 1.

Leaf oblong, narrowed to an obtuse point; midrib thick; lateral nerves few, distant, camptodrome; borders undulate-crenate.

The fragment representing this species is incomplete, the lower part of the leaf being destroyed. It seems cuneate to the base. The borders are regularly undulate or subcrenate; the lower secondary nerves, on one side at least, are more acutely diverging from the midrib, ascend higher, and anastomose near the borders with branches of the upper veins. This nervation is analogous to that of *I. Abichi*, Heer (Fl. Tert. Helv., p. 73, pl. cxxii, fig. 21), which has the leaves sparingly crenulate like ours, but of a different, broader, and rather broadly oval shape. The substance of this leaf is subcoriaceous.

HABITAT.—Green River, Wyoming (*Dr. F. V. Hayden*).

Ilex? affinis, Lesqx.

Plate L, Figs. 2, 3.

Ilex affinis, Lesqx., Supplement to Annual Report, 1871, p. 8.

Leaves coriaceous, oblong-ovate, broadly cuneate to the base, borders irregularly distantly dentate; nervation subcamptodrome.

These leaves, inequilateral at the base, seem like pinnules of a compound leaf. The midrib is thick, the secondary veins numerous, parallel, inequidistant, and, at an open angle of divergence, either enter the point of the teeth, and, by thin branches, follow the borders in festoons, or are truly camptodrome, with nervilles passing up from the back of the curves into the teeth. This nervation is not in conformity with that of the leaves of the dentate section of *Ilex*; it is rather analogous to that of some Oak leaves. The coriaceous substance of the leaves prevents a reference to *Quercus*. I

find moreover, in some fossil species of *Ilex*, *I. stenophylla*, Ung., *I. Berberidifolia*, Heer, a related type of nervation to that of these leaves, as figured in Fl. Tert. Helv., iii, pl. cxxii, fig. 7, for the first species, and figs. 13 and 14 for the second.

HABITAT.—Green River, Wyoming; with the former (*Dr. F. V. Hayden*).

Ilex subdenticulata, Lesqx

Plate L, Figs. 5, 6, 6 *a*, 6 *b*.

Ilex subdenticulata, Lesqx., Annual Report, 1873, p. 416.

Leaves small, coriaceous, narrowly lanceolate or linear-lanceolate; borders denticulate from above the narrowed base; lateral nerves distant, curving upward, and parallel to the borders.

The name of this species refers to its close affinity to Heer's *I. denticulata* rather than to the divisions of the borders, which are more marked than in the European form. The leaf of fig. 5 is larger, lanceolate, broader, and less attenuated at the base than that of fig. 6. Its lateral veins pass nearer to the borders in their curves, but they ascend quite as high, and join the upper veins outside of the middle. The details of nervation of this leaf, whose point is twisted into a short, obtuse acumen, are obsolete. It has the same texture as that of fig. 6. In this one, the lateral nerves curve upward in the middle of the areas, nearly parallel to the borders, forming, by anastomoses with the veins above, a double festoon and joined to the teeth outside by small branchlets. In *I. denticulata*, Heer (Fl. Tert. Helv., iii, p. 72, pl. cxxii, fig. 20), the lateral veins reach closer to the borders, which are denticulate in the upper part only. I consider the fruit in fig. 6 *a* (6 *b*, enlarged), found upon the same specimen as fig. 6, as referable to this species. It represents a small, crushed, berry-like drupe, with a small, ovate-pointed, hard nutlet, not flattened by compression.

HABITAT.—Near Florissant, Colorado (*Dr. A. C. Peale*).

Ilex dissimilis, sp. nov.

Plate L, Figs. 7–9.

Quercus Ilicoides? (Heer), Lesqx., Annual Report, 1871, p. 291.

Leaves coriaceous, variable in form and size, linear-lanceolate, cuneate or narrowed to the petiole, either regularly sharply dentate, or cut along the borders into distant horizontal short teeth, or long spiniform divisions; nervation subcamptodrome.

These leaves are so widely different in their characters, especially in their form and size, that they seem indeed referable at least to two species. They are, however, found, the only remains of dicotyledonous, upon the same fragments of shale, and have exactly the same color and consistence. The leaf of

fig. 7 is somewhat restored. It is, upon the specimen, split in two along the midrib, and the nervation, as well as that of fig. 9, is mostly obsolete; the point of the veins being so indistinct that it is not possible to see if they curve under the teeth or enter them. The nervation of fig. 8 is more distinct, and of the same character as that of fig. 6 of the former species. The shape of the fragmentary leaf of fig. 9, and its border divisions, are comparable to those of *Quercus Ilicoides*, Heer (Fl. Tert. Helv, iii, p 180, pl. cli, fig. 25); by the flat, apparently cartilaginous, border; it is also related to *I. dryandræfolia*, Sap. (Ét., 1, 2, p. 89, pl. 10, fig. 8), which, like this species, has smaller, narrower, linear leaves, either with shorter teeth or with large ones, deeply cut, in long spiniform divisions. The nervation is, however, different.

HABITAT.—Sage Creek, Montana, with *Sequoia Heerii;* this one represented in numerous fragments (*Dr. F. V. Hayden*).

RHAMNEÆ.

This family of plants does not occupy an important place in the present North American flora. It is there represented by a few species of shrubs of the genera *Paliurus*, *Zizyphus*, *Berchemia*, *Rhamnus*, *Ceanothus;* the three first of which by one species each, *Rhamnus* by three in the Atlantic and as many in the Pacific slope, and *Ceanothus* by four Eastern and eighteen Californian species. Two other genera, *Colubrina* and *Gouania*, have each one species in Florida. In the geological times, the species of this group appear in comparatively larger numbers, except, however, in *Ceanothus;* for European authors have described nine Miocene species of *Paliurus*, eighteen of *Zizyphus* of the same period, with three Eocene species. *Berchemia* has three, *Rhamnus* thirty-four, Miocene, mostly in the lower divisions of the formation, with one Eocene, and *Ceanothus* only one. As this family at the present epoch is generally distributed in tropical regions, *Zizyphus* in Asia and Africa, *Rhamnus* in South America, the numerous species of the Miocene serve as records of the climate. From the Eocene of Mississippi, one species of *Ceanothus* and one of *Rhamnus* have been published (Trans. Amer. Philos. Soc., vol. xiii, pp. 419, 420); the Cretaceous flora of the Dakota group has one leaf referred to *Paliurus*. Those described here seem to indicate in our Tertiary a distribution corresponding to that of the *Rhamneæ* in the European Miocene. Besides these, one *Zizyphus* and one *Ceanothus* are recognized in the Pliocene flora of California.

PALIURUS, Tourn.

Paliurus Colombi, Heer.

Plate L, Figs. 13–17.

Paliurus Colombi, Heer, Arct. Fl., i, p. 122, pl. xvii, fig. 2 *d*; xix, figs. 2–4; ii, p. 482, pl. l, figs. 18, 19; Spitzb. Mioc. Fl., p. 67, pl. xiv, fig. 11.—Lesqx., Annual Report, 1871, p. 288; 1872, p. 388.

Leaves oval, equally narrowed upward to an obtuse point and downward to a very short petiole; borders mostly entire, sometimes with one or two obtuse teeth; lateral nerves in an acute angle of divergence, curving inside, and anastomosing with secondary nerves or their branches toward the point; nervation camptodrome.

These leaves are slightly smaller than those figured by Heer; but, otherwise, they agree in all their characters; even, among the numerous specimens from Carbon, some fragments represent leaves quite as large as those from Greenland. All the large leaves have the borders entire; the small ones are sometimes marked by one or two obscure or obtuse teeth, a character indicated also in fig. 2 *d* of pl. xvii of the Arctic Flora; all are sessile, or nearly so, bearing only sometimes traces of a very short petiole (fig. 14 of our plate). They are triple-nerved from the base, the lateral nerves branching outside, ascending to above the middle, where they unite by branchlets to the secondary ones. These, generally few, three or four pairs, in the upper part of the leaves curve in passing to the borders, which they closely follow parallel to the branches, and anastomosing with them in simple festoons. One of the specimens to the leaf represented in the Arctic Flora (pl. xxvii, fig. 2 *d*) has, not in connection, but in the direction of its base, a fragment of a slender, apparently long, petiole. If the reference of this fragment to *Paliurus* is right, the petiole is there casually out of place, or the leaf may represent the species described before as *Populus decipiens* (p. 179, pl. xxiii, figs. 7–11), whose leaves are so very similar by their shape and nervation that I considered them at first, and from the specimen (fig. 7) deprived of a petiole, as representing the same species of *Paliurus*. This confusion is the more easily made, since the specimens of both are found together, especially at Carbon, where they are abundant. The difference is merely in the larger size and the shape of the leaves of *P. decipiens*, which, generally wider in the middle, bear a thin marginal veinlet from under the primary nerves, a character seen upon fig. 3, pl. xix, of the Arctic Flora. The first description of this *Paliurus* (in Annual Report, 1871, p. 288) was made from leaves of these two different species. By the shape of the leaves and the nervation, this species is allied to *Ceanothus thyrsiflorus*, Esch., of California.

HABITAT.—Washakie group, near Creston, Wyoming (*Dr. F. V. Hayden*). Carbon, Wyoming, where it is found, in numerous specimens, in the shale under the main coal, with *Populus arctica*, Heer, etc.

Paliurus Florissanti, Lesqx.

Plate L, Fig. 18.

Paliurus Florissanti, Lesqx., Annual Report, 1873, p. 416.

Leaf small, lanceolate, slightly crenulate, three-nerved from above the base; secondary nerves, four or five pairs, parallel, the lower distant from the primary ones.

This leaf, of which the point is broken, is very small, two and a half centimeters long, one centimeter broad, of a hard, not coriaceous substance, enlarged and rounded at the base to a short petiole, and gradually narrowed upward. The nervation is of the same type as in the former species; the lower nerves, however, joining the midrib a little above the border base, ascending in a curve and in a more open angle of divergence to below the middle of the leaf, where they anastomose with the secondary veins, which curve in a series of equal single bows quite near the borders. This nervation is analogous to that of *Paliurus aculeatus*, Lam., of Europe.

HABITAT.—Near Florissant, South Park, Colorado (*Prof. E. D. Cope*).

Paliurus zizyphoides, Lesqx.

Plate LI, Figs. 1–6.

Paliurus zizyphoides, Lesqx., Annual Report, 1872, pp. 384, 397.—Schp., Pal. Végét., iii, p. 611.

Leaves subcoriaceous, entire, oval, obtusely pointed, cuneate, rounded or truncate to a thick petiole, palmately five-nerved from the inflated base of the midrib; primary nerves branching, camptodrome, like their divisions.

These leaves, very variable in size, from two to seven centimeters both ways, and nearly round, are also sometimes oval, narrowed in an equal degree toward the point and to the petiole. The peculiar nervation seems to refer them to the same species. The straight, somewhat thick midrib is abruptly inflated above the base of the leaves, and the two or three pairs of primary nerves are successively attached to it, the inner ones at the top of the inflated part, the others lower. The lower lateral ones, either simple or branching, ascend to near the middle of the leaves, the internal higher up, sometimes to near the point, anastomosing upward in bows, with the secondary nerves placed, as in the former species, at a distance from the base. I do not find any affinity of this species with any of those known from the European Tertiary; the nervation is comparable to that of *Zizyphus platyphylla* of Brazil.

HABITAT.—Erie, near Golden, Colorado; a single small leaf Black Buttes, Wyoming, where it is not very rare.

ZIZYPHUS, Mill.

Zizyphus distortus, Lesqx.

Plate LI, Figs. 7–9.

Zizyphus distortus, Lesqx., Annual Report, 1873, p. 404.

Leaves membranaceous, very entire, rounded or truncate to the petiole, palmately five-nerved from the base; midrib thick; lower lateral veins simple, following the borders, the inner ones stronger, branching, curving inward and ascending higher up toward the point; nervation camptodrome.

The leaves vary in size from four to seven centimeters broad, and somewhat longer, the upper part being broken in all the specimens obtained. The nervation is that of the leaves of this genus, represented with borders entire, like *Z. protoleus*, Heer, etc.; though, in most of the fossil species described, it is generally simply three-palmate. The shape of the leaves slightly inequilateral, and the nervilles very close, numerous, and simple, at right angle to the nerves, are characters which relate them to *Zizyphus*.

HABITAT.—Golden, Colorado; rarely found, and always in fragments.

Zizyphus Meekii, Lesqx.

Plate LI, Figs. 10–14.

Zizyphus Meekii, Lesqx., Annual Report, 1872, pp. 388, 389.

Leaves subcoriaceous, ovoid, obtusely acuminate or pointed, rounded to the petiole, obtusely crenate, three- or five-nerved from the base.

The leaves differ little in their size and their characters. They average five centimeters in length and three in width; the borders are crenate or crenulate from quite near the base to near the obtuse point, which, either rounded or acuminate, is generally entire; the lateral outside primary nerves, not always present, curve along the borders, and anastomose below the middle of the leaves with branches of the internal ones; these ascend higher to the point or to near the point of the leaves, are more or less branched like the marginal ones, forming with their branches a simple series of bows connected to the teeth by straight, oblique nervilles, as seen in figs. 11 and 12. The fibrillæ, rarely discernible, are at right angle to the midrib, somewhat oblique to the lateral nerves, and close, mostly simple. This species is allied to *Z. ovatus*, Web. (Palæont., ii, p. 203, pl. xxii, fig. 12; xxiii, fig. 1), whose leaves, however, have the lateral nerves simple and more distinctly acrodrome. It has a more marked relation to the following species, of which it looks like a diminutive form, and is comparable also by the shape of the leaves to *Grewia crenata* of Heer.

HABITAT.—Carbon, Wyoming; in the clay-shale, both above and below the main coal; abundant. *Prof. F. B. Meek* sent specimens also from the same locality. All the leaves are equilateral at the base; those of the small size, like fig. 13, are more frequent.

Zizyphus hyperboreus?, Heer.

Plate LI, Fig. 15.

Zizyphus hyperboreus?, Heer, Fl. Arct., i, p. 123, pl. xlix, fig. 2; ii, p. 482, pl. l, fig. 20.—Lesqx., Annual Report, 1872, p. 389.

Leaves ovate-lanceolate, acuminate, three- or five-nerved; borders undulato-crenate.

Though the form of the leaves is like that of fig. 20 of Heer, I am not certain of an identity with the Greenland species, which has the primary nerves rather in five than in three, and the outside branches less numerous and more oblique. The fragments figured by Prof. Heer are incomplete. He remarks, however (p. 482, *loc. cit.*), that he has seen, in Mr. Whymper's collection, a large and better preserved leaf, elliptical, acuminate, and toothed. All the varieties of shape and of denticulation are marked in the former species, of which, as just said, this leaf may be a variety.

HABITAT.—Carbon, Wyoming. Other fragments as large as this show the borders more distinctly crenate.

Zizyphus fibrillosus, Lesqx.

Plate LII, Figs. 1-6

Ceanothus fibrillosus, Lesqx., Annual Report, 1872, p. 381; 1873, p. 404.—Schp., Pal. Végét., iii, p. 612.

Leaves rather coriaceous, very entire, ovate-acuminate, rounded or cordate to the base, three- to five-nerved; inner primary nerves subacrodrome.

These leaves, by their multiplied basilar nervation, are rather referable to *Zizyphus* than to *Ceanothus;* for the primary nerves are of the same distribution as in the former species, and the shape of the leaves also is about the same. It is, however, variable, the base being merely rounded, as in figs. 1, 3, 4, or cordate, as in fig. 2, or tapering to a long acumen, as in fig. 6, which shows the inner lateral nerves acrodrome. The nervation is apparently trifid from a little above the base of the leaves, as seen in fig. 3; the lower lateral veins being there merely marginal, joined to the midrib lower than the base of the primary ones, and these being divided into two branches, of which the inner one only is primary (figs. 1, 3). The nervilles are very close, distinct, simple, in right angle to the midrib, oblique to the lateral nerves and their branches. No trace of areolation is discernible.

HABITAT.—Golden, Colorado, and Black Buttes, Wyoming; rare.

Zizyphus cinnamomoides, Lesqx.

Plate LII, Figs. 7, 8.

Ceanothus cinnamomoides, Lesqx., Annual Report, 1871, p. 289.

Leaves membranaceous, oblong, narrowly cuneate to the base, obtusely distantly dentate below the middle upward; nervation trifid.

The relation of these two fragments of leaves, whose upper part is destroyed, is with *Ceanothus zizyphoides*, Ung., as described and figured by Heer (Fl. Tert. Helv., iii, p. 74, pl. cxxii, fig. 25) under the name of *Zizyphus Ungeri*. But they differ evidently by the primary lateral veins, which, shorter, ascend to above the middle, where they anastomose with branches of the midrib. In Unger's species, the midrib is simple and the lateral nerves acrodrome. The details of nervation are quite distinct and as figured, being formed by subdivisions of the nervilles, nearly in right angle, of small equilateral or quadrate meshes. The borders are obtusely toothed rather than crenate; the teeth do not appear to be entered by the branches, but only by nervilles.

HABITAT.—Green River Station, Wyoming, above the fish-beds, with *Ampelopsis tertiaria*, etc. (*Dr. F. V. Hayden*).

BERCHEMIA, Neck.

Berchemia multinervis, Al. Br.

Plate LII, Figs. 9, 10.

Berchemia multinervis, Heer, Fl. Tert. Helv., p. 77, pl. cxiii, figs. 9–18.—Sism., Prod., p. 15; Mater., p. 64, pl. xxix, fig. 8.—Sap., Ét., iii, p. 107, pl. xii, figs. 2, 3.—Ett., Foss. Fl. v. Bil., iii, p. 41, pl. xlix, figs. 15–17.

Rhamnus multinervis, Al. Br., in Buckl. Geol., p. 513.

Karwinskia multinervis, Al. Br., in Leonh. and Bronn, Jahrb., 1845, p. 172.—Ung., Chlor. Protog., p. 147, pl. l, fig. 4.

Karwinskia Œningensis, Al. Br., in Bruckm. Verz., p. 232.

Berchemia parvifolia, Lesqx., Annual Report, 1869, p. 196; Supplement to Annual Report, 1871, p. 15.

Leaves ovate-obtuse, rounded to the petiole; borders very entire; lateral nerves numerous, close, parallel, slightly curved, subopposite, simple, camptodrome; nervilles close, numerous, distinct, simple or branching.

I remarked in the last memoir quoted above that the name given to the first leaf (fig. 9), communicated by Dr. J. Leconte from Raton Pass, was not appropriate, as a new specimen had been sent from the Raton Lignitic, with a leaf as large as those of our common *B. volubilis*, to which the fossil species is closely related. I then remarked also that the American form merely differed from that of the European Miocene, as represented by Heer (*loc. cit.*), by the secondary nerves being open from the midrib, while they are slightly turned downward at their point of contact in the figures given by this author. But other leaves, represented by Saporta, d'Ettingshausen,

and some of the authors quoted above, represent the divergence of the secondary nerves quite in the same way as it is seen upon the specimens of the Raton Mountains, and, therefore, no difference could be mentioned to authorize a separation of species.

HABITAT.—Raton Mountains, near Trinidad, New Mexico (*Dr. J. Leconte, Dr. F. V. Hayden*). By error, it was credited, in Annual Report, 1873, p. 105, to Marshall's Coal, Colorado, which is of the same group.

RHAMNUS, Linn.

The distribution of the species of this genus, both in the flora of our time and in that of the geological periods, has been briefly indicated in the remarks on the family of the *Rhamneæ*. The leaves of *Rhamnus* are alternate, either coriaceous and persistent, or membranaceous and deciduous, ovate, obovate, lanceolate, oblong, often glabrous, entire or with the borders more or less minutely dentate. The nervation is pinnate, the lateral nerves mostly simple, rarely branching, and camptodrome in the leaves, whose borders are entire, close, parallel, connected with numerous distinct nervilles either in right angle, or more generally oblique to the lateral nerves. Some of the species described in this generic division are of a peculiar type, the secondary nerves being very close, sometimes branching toward the borders. They may be referable, according to Schimper, to some *Euphorbiaceæ*, like *Bridelia*, a New Holland genus, or, in the opinion of Saporta, to his genus *Artocarpoides* of the *Moreæ*. In this uncertainty, and without sufficient means of comparison with living Australian plants, I have left them as formerly described in this division. Moreover, I find in species of *Rhamnus*, especially of *Rhamnidium* of Brazil, characters in accordance with those of our leaves.

Rhamnus alaternoides, Heer.

Plate LII, Figs. 11, 11 *a*.

Rhamnus alaternoides, Heer, Fl. Tert. Helv., iii, p. 78, pl. cxxiv, figs. 21, 23.—Lesqx., Annual Report, 1873, p. 405.

Leaves small, subcoriaceous, elliptical, obtusely pointed, narrowed to the petiole, dentate.

This small leaf, fourteen millimeters long, seven broad, has the lower pair of lateral nerves opposite, and emerging a little above the base; the others alternate, parallel, camptodrome, joined to the teeth by oblique veinlets, and the borders distinctly dentate. It seems to agree in all its characters with Heer's species, represented by three leaves, one of which is entire, the

others dentate. These have the same character of nervation as marked in fig. 11 *a*, enlarged.

HABITAT.—Golden, South Table Mountain, Colorado; one specimen only.

Rhamnus rectinervis, Heer.

Plate LII, Figs. 12–15.

Rhamnus rectinervis, Heer, Fl. Tert. Helv., iii, p. 80, pl. cxxv, figs. 2, 6.—Lesqx., Annual Report, 1871, pp. 295, 298; Supplement, p. 12; Annual Report, 1872, pp. 382, 397, 402; 1873, p. 405.

Leaves subcoriaceous, oblong, entire, dentate only toward the point; secondary nerves, eight to twelve pairs on an acute angle of divergence, camptodrome.

The specimens which I refer to this species are numerous in the Lower Lignitic of Colorado and Wyoming. The leaves are rather large, indistinctly dentate toward the point; the secondary nerves, more open in joining the midrib, ascend straight to the borders under an angle of divergence of 30° to 40°, sometimes inequidistant, and generally parallel. Comparing the fragment of fig. 12 to fig. 6 of Heer (*loc. cit.*), the identity of the characters is evident. Our fig. 13 is more obtuse, the veins less distant, and at a more open angle of divergence. It seems at first referable to another species; but it is upon the same specimen as fig. 12, has the same facies, and, indeed, there are other fragments which indicate intermediate characters; none, however, with the point preserved but this one. Fig. 15 is more doubtfully referable to this species on account of the very close nervilles.

HABITAT.—Black Buttes, Wyoming, and Golden, Colorado, mostly. The specimen represented in fig. 15 is from the Cañon Coal-Measures, by *Dr. A. C. Peale*. Found also at Evanston, Wyoming; six miles above Spring Cañon, Montana; and the Raton Mountains, New Mexico, by *Dr. F. V. Hayden*, mostly in fragmentary specimens.

Rhamnus inæqualis, Lesqx.

Plate LII, Fig. 16.

Rhamnus inæqualis, Lesqx., Annual Report, 1873, p. 405.

Leaf small, subcoriaceous, very entire, inequilateral; secondary nerves alternate, on an acute angle of divergence, straight to the borders, camptodrome.

This fragment is rather of uncertain relation; the direction of the secondary nerves, the inequilateral shape, and the oblique, close nervilles referring it to this genus by a distant likeness to *R. Œningensis*, Heer, of the European Miocene; the branching of one of these nerves, however, is in contradiction to the general character of nervation of species of *Rhamnus*.

The form and size are the same as those of the leaf referred to *Diospyros brachysepala* (pl. xl, fig. 7); but the nervation is of a different type. But for the branching of one of its nerves, it would be referable to *R. Dechenii*, Heer.

HABITAT.—Golden, South Table Mountain, Colorado.

Rhamnus? discolor, Lesqx.

Plate LII, Fig. 17.

Rhamnus discolor, Lesqx., Annual Report, 1872, p. 398.

Leaf oval, broadly cuneate to the petiole, very entire, membranaceous; nervation camptodrome; secondary nerves close, parallel, connected by numerous, distinct, oblique nervilles.

As for the former leaf, the generic relation of this one might be contradicted. The leaf is much like that described and figured as *Quercus straminea* (pl. xix, fig. 7). But if the shape is the same, the nervation is far different. All the veins are black; covered with a thin coating of coaly matter, as if they had been originally villous. They are all simple, or without any trace of branch, reaching straight to the borders on a more acute angle of divergence, and without any trace of tertiary intermixed nerves, which separate nearly all the secondary ones in the leaf of pl. xix. The texture also seems to be more thick and compact. This *Rhamnus* is related to *R. brevifolius*, Al. Br. (in Heer, Fl. Tert. Helv., p. 78, pl. cxxiii, figs. 27, 30), differing by the shape and the larger size of the leaves, which, by their form, relate the species to *R. Purshianus*, D C., a species now living in Oregon.

HABITAT.—Black Buttes, Wyoming; very rare.

Rhamnus Cleburni, Lesqx.

Plate LIII, Figs. 1–3.

Rhamnus Cleburni, Lesqx., Annual Report, 1872, pp. 381, 400.—Schp., Pal. Végét., iii, p. 611.

Leaves somewhat thick, but not coriaceous, very entire, elliptical or lanceolate, taper-pointed, narrowed to a comparatively long, slender petiole; secondary veins close, parallel, scarcely curved in traversing the lamina, forming a series of simple bows very near the borders, joined by very close nervilles.

These leaves, like those of the following species, belong to the section mentioned above, whose relation is considered by European authors as more marked with *Euphorbiaceæ* or *Moreæ*. The leaves are of large size, more or less acutely pointed, with the base cuneate, and with numerous alternate lateral nerves diverging about 40° from the narrow midrib. Fig. 3 resembles fig. 5 of pl. xlii, described as a *Cornus*. Its lateral nerves are, however, closer, about twice as numerous, not curved or slightly so in passing up to the borders,

scarcely divided; and the nervilles also and the areolation are of a different character. The few branches seen toward the upper part of some of the nerves are rather inflated nervilles than true branches, like those of the living *R. lanceolatus*, Pursh., *R. Wulfenii*, Spreng, etc. I have remarked, in the Report (*loc. cit.*), that, when the fructification of this and the following species are known, they will probably constitute a separate group.

HABITAT.—Golden, Colorado; common. Very rare at Black Buttes, Wyoming. *Prof. F. B. Meek* found two fine leaves of this species in burned red shale at a short distance west of Black Buttes, Wyoming.

Rhamnus Goldianus, Lesqx.

Plate LIII, Figs. 4–8.

Rhamnus Goldianus, Lesqx., Annual Report, 1872, p. 381; 1873, p. 405.—Schp., Pal. Végét., iii, p. 612.

Leaves of small size, of the same consistence as those of the former species, oval or ovate, obtusely pointed or acuminate, subcordate or rounded to a short petiole.

These leaves are still more abundant at Golden than those of the former species, from which they merely differ by the generally smaller size, the base rounded or subcordate to a shorter petiole, the lateral veins generally more numerous, and the lower ones more or less branching. Fig. 7, the smallest of these leaves, resembles *Berchemia multinervis*, Heer, differing merely by the branching of the lower lateral nerves, a character remarked in all the leaves of the species, though variable their size and shape may be.

HABITAT.—Golden, Colorado. Rare at Black Buttes, Wyoming. One specimen, representing the large form, is from Carbon, Wyoming.

Rhamnus obovatus, Lesqx.

Plate LIV, Figs. 1, 2.

Rhamnus obovatus, Lesqx., Annual Report, 1869, p. 197; 1872, pp. 375, 381, 402.

Leaves subcoriaceous, very entire, oblanceolate or obovate, gradually rounded to an obtuse point; lateral nerves very close, straight to the borders, camptodrome.

These leaves vary in size from seven to nine centimeters long, without the petiole, and from one and a half to three and a half centimeters broad toward the point, where they are widest, gradually narrowing downward to a short petiole. The middle nerve is thick, the secondary veins very close and numerous, two millimeters distant, eighteen to twenty-two pairs in each leaf, thin, parallel, straight, with their bows just on the borders, and scarcely discernible. By this nervation, they are rather referable to *Berchemia*, having their lateral nerves still more numerous than *B. multinervis*.

HABITAT.—The first specimens were communicated by *Dr. J. L. LeConte* from the upper end of Purgatory Cañon, New Mexico. I found some later at Golden, Colorado, and small fragments at Evanston, Wyoming. These last, very incomplete, may be referable to the following species.

Rhamnus intermedius, Lesqx.

Plate LIV, Fig. 3.

Rhamnus intermedius, Lesqx., Annual Report, 1871, p. 286.

Leaf oblong-elliptical, somewhat thick, very entire; secondary nerves close and numerous, thick, camptodrome.

By its close nervation, this leaf, the only one found, is allied to the former species, differing evidently, however, by the thick lateral veins, slightly more curved in traversing the lamina, and by the bows, which, though close to the borders, are easily discernible. The shape is elliptical; the top and base being apparently obtuse. It rather resembles a *Berchemia* than a *Rhamnus*. The characters are intermediate between those of the former and of the following species.

HABITAT.—Near Bridger's Pass, Wyoming, with *Platanus Haydenii*, *Magnolia* species, etc., a station referable to the first or second group.

Rhamnus salicifolius, Lesqx.

Plate LIII, Figs. 9, 10.

Rhamnus salicifolius, Lesqx., Annual Report, 1869, p. 196; 1872, p. 400.

Leaves narrowly lanceolate, acuminate, narrowed to a short petiole, entire; secondary veins at an acute angle of divergence; nervilles close, very thin.

These leaves are comparatively longer and narrower than those of the former species, the lateral nerves less numerous, more variable in distance, at an angle of divergence of 25° to 30°. They are slightly more curved in joining the midrib, and not as thick, becoming nearly indistinct close to the borders. This species is closely related, by the characters of its leaves, to *R. Carolinianus*, Walt., a species now inhabiting the swamps of the Southern States. The direction of the lateral nerves is the same as in *R. rectinervis*, from which it differs by the borders being entire at the narrowly tapering point.

HABITAT.—Marshall's Mine, Colorado (*Dr. F. V. Hayden*). The specimen represented in fig. 10 was communicated by *Prof. F. B. Meek* from Black Buttes, Wyoming.

Rhamnus Rossmässleri, Ung.

Plate LIV, Fig. 4.

Rhamnus Rossmässleri, Ung., Gen. et Sp., p. 464.—Heer, Fl. Tert. Helv., iii, p. 80, pl. cxxiv, figs. 18–20.
Phyllites rhamnoides, Rossm., Beitr. z. Verstein., pl. viii, figs. 30, 31.
Rhamnus aizoides, Ung., Sillog., ii, p. 17, pl. iii, f. 47?.

Leaves narrowly obovate, obtusely pointed, very entire; lateral nerves curving in passing to the borders; nervilles thin.

The shape of the leaves, somewhat inequilateral, with the obtuse point slightly turned to one side; their size also, five centimeters long and three broad, the direction and relative distance of the lateral nerves, are the same as in the leaves of this species, figured by Heer from the Miocene of Switzerland. The average angle of divergence of the lateral nerves is 40° to 50°; their simple bows follow quite near the borders. I am unable to point out any difference between this and the European leaves described under this name.

HABITAT.—Black Buttes, Wyoming, in sandy shale above the main coal. The only leaf found.

TEREBINTHINEÆ.

JUGLANDEÆ.

The distribution of the species of this family in the geological times, compared with that of our present flora, presents for Europe a peculiar anomaly, and for North America a remarkable analogy. We find *Juglans* already represented in the European Cretaceous by one species, described by Heer, from Moletin. The leaflets are very large and with entire borders. There is apparently also one species present in the Cretaceous of Nebraska, for numerous leaflets of compound leaves have been referred, with doubt, however, to this genus from the Dakota group. From the Eocene of Europe, three species of *Juglandites* are described, in the Sézanne Flora by Count Saporta, from leaflets either entire or minutely denticulate, both characters represented in the leaflets of the same species, as if we had here the first traces of denticulation in leaves of *Juglans*. Higher up in the Tertiary formations, or from the lowest part of the Miocene to its end, European paleontologists have found a very large number of species of this family, not less for *Juglans* than fourteen, represented by entire leaflets, ten by serrate ones, and twelve by fruits, besides seven more, of uncertain affinity, described by Massalongo. Of the genus *Carya*, they have, in the same Upper

Tertiary formations, twenty-one species, described either from leaflets only, or from leaves and fruits found together, or from fruits alone; and, besides, six species of *Pterocarya*.

At the present time, one species only of *Juglans* is known. Its leaflets have the borders entire. It is the noble *J. regia*, Linn., which, by cultivation in Middle and Southern Europe, has given numerous varieties, all bearing fruits, known everywhere as palatable and nutritious food. In its wild state, it inhabits the trans-Caucasian provinces of Asia. In the section of the serrate leaflets, *Juglans* has three well-known species: *J. nigra*, Linn., *J. cinerea*, Linn., of the Eastern United States of North America, and *J. rupestris*, Engelm., indigenous in New Mexico; a fourth species, whose fruit resembles that of the Butternut, is found in Asiatic Russia. In the genus *Carya*, all the living species, nine, belong also to the eastern slope of this continent. One only, which is mentioned as not satisfactorily known, belongs to Mexico. From this, it is evident that there is in Europe an anomaly of distribution in considering the numerous species there known from the Tertiary, while none at all is left in the flora of that continent. In North America, species of *Juglans* are already represented in the Eocene of Golden, Black Buttes, Spring Cañon, etc., mostly by leaflets with entire borders, more numerous still at Evanston and in the Green River group. Of the section of dentate leaflets, two species have been described from the Eocene of the Mississippi; none, however, from that of the Rocky Mountains. They appear first in the Evanston group, and continue in an increasing proportion upward, while those of the other section become less preponderant, as evinced in the Pliocene of California, where one species only of this last section is present, while it has four distinct ones with denticulate or serrate leaflets. This seems like a premonstration of the present character of our *Juglandineæ*, which all have dentate or serrate leaflets, and of the future preponderance of their species.

JUGLANS, Linn.

§ 1.—*Leaflets entire.*

Juglans rhamnoides, Lesqx.

Plate LIV, Figs. 6-9.

Juglans rhamnoides, Lesqx., Annual Report, 1871, p. 294; 1872, pp. 382, 400, 402.

Leaves oval, narrowed in a curve or rounded to the petiole, very entire; lateral nerves thin, distant, curved in passing to the borders, camptodrome.

The leaflets are apparently taper-pointed or acuminate, very variable in size, like all those referred to this section; the lateral nerves averaging 40° of

divergence, are simple or sparingly branching, connected by very thin distant nervilles in right angle to the veins. As remarked in Report, 1871 (*loc. cit.*), it is difficult to decide if these leaves represent a *Juglans* or a *Rhamnus*. Prof. Heer has, in Arct. Fl., i, p. 123, pl. xlix, fig. 10, a leaf whose characters are much like those of this species; the lateral nerves are, however, more oblique to the midrib, all simple, and straight to the borders. It is described as *Rhamnus Eridani*. The author remarks on this leaf, that, but for the straight secondary nerves, it should be referable to *Juglans*. Therefore the curved secondary nerves of our species relate it to this genus. But in the leaves which represent it, the lateral veins are somewhat closer, and pass nearer to the borders than in any species of *Juglans*, except perhaps *J. acuminata*, Al. Br., which, in Fl. Alas., pl. ix, fig. 1, is represented by Heer with secondary veins equidistant and reaching nearer to the borders than in any other figure of this species. *J. rhamnoides* is therefore closely related to *J. acuminata*, and, as it bears the same relation to *J. rugosa* and *J. Leconteana*, Lesqx., they all may be mere varieties of the polymorphous *J. acuminata*, which has been found in the whole extent of the Miocene of Europe. This species is apparently identical with *Cornus acuminata*, Newby.

HABITAT.—Spring Cañon, Montana (*Dr. F. V. Hayden*). Not rare at Black Buttes, Wyoming. Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Juglans Leconteana, Lesqx.

Plate LIV, Figs. 10–13.

Leaves broadly ovate, gradually acuminate, narrowed and rounded to a short petiole; borders undulate; nervation coarse, thick; lateral nerves on an acute angle of divergence, slightly curved in passing to the borders.

This species or form was merely mentioned in Annual Report, 1869, p. 197, and I was a long time in doubt if it could really be separated from the following. From it and from all the figures which represent *J. acuminata*, it differs by comparatively shorter and broader leaves, which are first rounded and then abruptly curved or narrowed to the short petiole; by the lateral nerves on a more acute angle of divergence, 40°, passing nearly straight toward the borders, with their simple bows nearer to them, a nervation resembling that of *Rhamnus* still more distinctly than that of the former species. There are no intermediate tertiary veins; the fibrillæ, at right angle to the nerves and obliquely branched, compose an irregularly quadrate or polygonal areolation.

HABITAT.—Marshall's Mine, Colorado, the fragments represented in figs.

10–12 (*Dr. J. L. LeConte*). These fragments were originally figured for a series of plates which have not been published. They have been preserved without modification. Fig. 13 is from a specimen found at Evanston, Wyoming, with numerous ones of the following species.

Juglans rugosa, Lesqx.

Plate LIV, Figs. 5, 14; Plate LV, Figs. 1–9; Plate LVI, figs. 1, 2.

Juglans rugosa, Lesqx., Annual Report, 1869, p. 196; 1871, pp. 287, 298; Supplement, pp. 10, 12; 1872, pp. 382, 390, 404, 407.
Juglans acuminata? (Al. Br.), Lesqx., Annual Report, 1871, p. 288; Supplement, p. 8.

Leaves variable in size, subcoriaceous, wrinkled-rugose on the surface, entire, undulate, oblong-oval, abruptly acuminate, rounded to a short petiole; lateral nerves open, curved, thick; nervilles thick, branching in right angle; areolation irregularly quadrate.

The leaves are oblong, rarely enlarged in the middle, rounded, broadly cuneate, even subcordate at the base. The nervation is very deeply marked, coarse, and therefore the surface runcinate. It is besides generally rugose. The degree of relation of this species to *J. acuminata* is so clearly marked that I have been for years, and am still, uncertain, if the numerous leaves which represent it, and which are found especially in the first and second groups of the Lower Lignitic, should not be referable as mere varieties to *J. acuminata*, so widely distributed in the Miocene of Europe. The differences are especially in the oblong shape of the leaflets, whose borders, more undulate than in the European forms, are generally nearly parallel in the middle; more abruptly acuminate, and the surface rough. But in the numerous specimens which I have examined, some have the characters of *J. acuminata*, as the point represented in pl. lv, fig. 9, or the gradually narrowed base of fig. 5, same plate. It is thus evidently an American form, whose degree of relation to the European species can be ascertained only by the comparison of specimens.

HABITAT.—Six miles above Spring Cañon, near Fort Ellis, Montana; Evanston, Wyoming; very abundant at these localities (*Dr. F. V. Hayden*). Plate lv is composed mostly of Evanston specimens—Black Buttes, Wyoming, and Golden, Colorado; less common. One of the specimens communicated by *Dr. A. R. Marvine* bears the label, "South borders of North Park", a locality whose geological station is unknown to me. As there is from the same station a leaf of *Cissus lobato-crenata* and fragments of *Sabal*, I consider it as Lower Lignitic.

Juglans thermalis, Lesqx

Plate LVI, Figs. 3, 4.

Juglans thermalis, Lesqx., Supplement to Annual Report, 1871, p. 17.

Leaves oval-oblong or ovate-lanceolate, pointed or acuminate, rounded in narrowing to the petiole; lateral nerves distant, curved; fibrillæ strong, in right angle to the nerves.

The nervation of this species is remarkably different from that of the former; the lower lateral nerves being opposite at a distance above the base of the leaves, and at a more acute angle of divergence, simple, all, like the others, connected by strong nervilles, and more or less curved in traversing the lamina. The midrib is rather narrow, but rigid; the nervilles coming out of the middle nerves in fig. 3 are as strong as tertiary veins, and as long, anastomosing with the lateral nerves in the middle of the areas, or even near the borders. The shape and nervation of the fragment of fig. 4 differ somewhat, the upper part being more gradually tapering or lanceolate, and the nervilles being close and not so strongly marked. The lower lateral nerves are, however, as in fig. 3, on a more acute angle of divergence, and apparently joining the midrib above the base of the leaf. This species is comparable, for the nervation of fig. 3 at least, to *J. longifolia*, Heer (Fl. Tert. Helv., pl. cxxix, fig. 10).

Habitat.—Hot Springs, Middle Park, Colorado; in conglomerate volcanic deposits (*Dr. F. V. Hayden*). The specimen represented in fig. 4 was found at Golden, Colorado.

Juglans Schimperi, Lesqx.

Plate LVI, Figs. 5–10.

Juglans Schimperi, Lesqx., Supplement to Annual Report, 1871, p. 8; Annual Report, 1872, pp. 382, 384.

Leaves lanceolate, gradually acuminate, broadly cuneate and rounded at the inequilateral base to a short petiole; borders slightly undulate; secondary nerves numerous, parallel, curved, closely following the borders; nervilles distinct; areolation subquadrate.

This fine species is represented by many specimens. Its leaves are generally narrow and long, gradually tapering from above the base into a long acumen, the size varying from eight to fourteen centimeters long, and from two to three and a half centimeters broad in the widest part near the base. The lateral nerves, diverging 40° to 50°, are numerous, eighteen pairs in the largest leaves, parallel, mostly simple, slightly curved in ascending to the middle of the areas, but more and gradually so in nearing the borders, which they closely follow in simple bows. They are connected by close distinct nervilles, generally in right angle. No fossil species of this section is com-

parable to this one. The specimen represented in fig. 9, a mere fragment from another locality, is somewhat different by the lateral nerves more evidently branching and more oblique. The lower veins of fig. 5 have, however, the same characters. The specimen represented in fig. 10 has the lower lateral nerves more open, a difference unimportant in the determination of species of *Juglans*.

HABITAT.—Green River, Wyoming, above fish-beds (*Dr. F. V. Hayden*). The fragment represented in fig. 9 is from Golden, Colorado. It may belong to a different species.

§ 2.—*Leaflets crenate or dentate.*

Juglans alkalina, Lesqx.

Plate LXII, Figs. 6–9.

Juglans alkalina, Lesqx., Annual Report, 1874, p. 308.

Leaves lanceolate, acuminate, rounded or narrowed in a curve to a short petiole; borders crenulate; lateral veins distant, mostly alternate, parallel, curved in passing toward the borders, ascending high along them in simple festoons, separated by short intermediate tertiary veins; nervilles in right angle, strong; areolation irregularly quadrate.

This species, very fine and distinct, is related, by the facies of the leaves, to the *Juglandites* of the Sézanne Flora, which have, however, a different character of nervation. The American leaves have the lateral nerves more distant, and their base is not narrowed in the same degree. They are, moreover, much smaller, from five to twelve centimeters long and from two to four centimeters broad. This species is also comparable to *J. bilinica*, Ung., presenting, however, the same kind of difference in the more distant and more oblique lateral nerves, ascending higher along the borders, which are merely crenulate and not denticulate. As seen from the figures, the leaves are more or less unequal at the base, and more or less narrowed or rounded to the petiole; but they do not differ in the essential characters. Variations of the same kind are generally observed upon leaflets of the same species of *Juglans* and *Carya*. The bows along the borders are not connected with the teeth by nervilles.

HABITAT.—Alkali Station, Wyoming (*Wm. Cleburn*).

Juglans denticulata, Heer

Plate LVIII, Fig. 1.

Juglans denticulata, Heer, Fl. Foss. Arct., ii, p. 483, pl. lvi, figs. 6–9.—Lesqx., Annual Report, 1871, p. 298; Supplement, p. 8; Annual Report, 1872, pp. 389, 408.

Leaves long, lanceolate, narrowed to a point, and denticulate upward; either rounded to the petiole, or gradually attenuated to it.

The leaves of this species vary so widely that none of the descriptions made in the different reports, and from specimens received at different times, are alike. As in the figures given by Heer (*loc. cit.*), some of our specimens represent small leaves rounded to the petiole, with lateral veins generally open; others have the base more or less narrowly cuneate and the veins more oblique. Fig. 1 of this plate represents the best specimen which I have had for examination. It differs from most of the Greenland leaves by the lateral veins being more open, but not more so than in fig. 6 of Heer. A persistent character is the dentation of the borders toward the point of the leaflets; it is generally more or less discernible. The upper lateral veins also are connected with the point of the teeth by distinct nervilles from the back of the festoons, and the base of the leaflets is generally entire. Prof. Heer, comparing his species to *Juglans bilinica*, remarks, that the arches of the secondary veins run nearer to the borders, a character which is seen upon all the fragments which I have referred to this species.

Habitat.—Green River, Wyoming, above fish-beds; six miles above Spring Cañon, Montana (*Dr. F. V. Hayden*). Carbon, above the main coal; not frequent, and generally in fragments.

CARYA, Nutt.

Carya antiquorum, Newby.

Plate LVII, Figs. 1–5; Plate LVIII, Fig. 2.

Carya antiquorum, Newby., Notes on the Later Extinct Floras of North America, p. 72.—Lesqx., Annual Report, 1871, p. 294; 1872, p. 402.

Leaflets large, broadly oval or ovate-lanceolate, acuminate, rounded or broadly cuneate to the petiole; base inequilateral; borders minutely denticulate; lateral nerves close, parallel, simple, curved in ascending toward the borders.

The leaflets of this species are very large, except those of the lowest pair, whose size is, as in species of *Juglans*, generally diminutive; part of fig. 3 and fig. 5 represent them. The largest, in the upper part of fig. 1, is more than nine centimeters long below the middle, and its length could not have been less than twenty centimeters. Fragmentary specimens in Dr. F.

V. Hayden's collection indicate leaflets of still larger size. The substance of these leaflets is subcoriaceous and rigid, the surface generally polished, though deeply cut by numerous lateral nerves and nervilles; the borders, crenulate or denticulate, become entire toward the more or less inequilateral base, of which one side is generally rounded, the other straight, The petiole of the lateral leaflets is short; that of the terminal ones longer, as represented in fig. 2. The lateral nerves are close, twenty to twenty-five pairs in the large leaflets, under a broad angle of divergence, 50° to 60°, mostly simple, closely following the borders in simple bows, connected with the teeth by minute short nervilles. Though this species has been ably and distinctly described by Prof. Newberry, the abundant materials which I have at hand, representing its leaflets in their diversified size and shape, have induced me to give figures of those which show its more marked characters. The generic relation of the species cannot be definitely considered as long as the fruit is not known. As the North American species of *Juglans* and *Carya* can be used only as points of comparison by the characters of their leaves, these characters, especially the generally simple secondary nerves in our species of *Juglans*, more generally divided in those of *Carya*, seem to refer this fine species, whose lateral nerves are not at all divided, to the first genus. The size of the leaflets, however, has more likeness to those of *Carya alba*, though all the fossil leaflets of *Carya* published by European authors are narrow and linear, and also the branching of the nerves is quite as distinct in *Juglans rupestris* as in the species of *Carya*.

HABITAT.—Evanston, Wyoming, below the main coal (*Dr. F. V. Hayden*). It is there abundant, and I have obtained it in very fine specimens, but have not seen it anywhere else.

PTEROCARYA, Kunth.

Pterocarya Americana, Lesqx.

Plate LVIII, Fig. 3.

Pterocarya Americana, Lesqx., Annual Report, 1873, p. 417.

Leaflets oblong, apparently lanceolate upward, and narrowed to the base; lateral nerves more open toward the base, parallel, inequidistant, slightly curved.

The lateral nerves are more distant and more irregularly distributed than in species of *Carya*, and also the arches do not reach quite as near the borders. I compared this species (*loc. cit.*) to *Pterocarya Massalongi*, Gaud. (Contr., i, p. 40, pl. ix, fig. 2), the form of the leaflets, their nervation, and border divis-

ions being very similar. *Pterocarya* merely differs, in the characters of its leaflets, by more distant and irregular secondary nerves. But this character does not seem any more marked in this leaf than in some other fossil ones described by authors as *Carya*, especially *C. elænoides*, Heer. As this fragment comes from the Upper Miocene of the Rocky Mountains, and as *Pterocarya* is an Asiatic genus, and therefore representative of a flora to which the North American has no analogy, it would be more advisable to consider the fragment as that of a leaflet of *Carya* or of *Juglans*.

HABITAT.—Middle Park, Colorado; a single specimen (*Dr. F. V. Hayden*).

ANACARDIACEÆ.

RHUS, Linn.

This genus has, in the present flora, a large number of species, especially inhabiting the subtropical regions, mostly in Southern Africa and North and South America. The flora of the United States has nine species, three of which are limited to the Pacific coast. In the geological times, this genus is represented in the Lower Miocene of Europe, the Armissan especially, by nearly fifty species, a number of which are found higher, in the Upper Miocene, but none as yet in the Pliocene. In the fossil flora of North America, it appears in the Lower Lignitic Eocene in two species, is present in the Evanston group, more abundant in the Upper Miocene, and predominant indeed in the Pliocene of California, which has a number of its representatives, especially of the types of *R. Typhina* and *R. metopium*, two sections mostly, if not exclusively, American at our epoch

Rhus Evansii, Lesqx.

Plate L, Fig. 4; Plate LVIII, Figs. 5-9.

Rhus Evansii, Lesqx., Annual Report, 1871, p. 293; 1872, p. 402.

Leaves pinnately compound; leaflets variable in size, ovate-lanceolate, acuminate, round or subcordate to the petiole; borders denticulate; nervation craspedodrome.

These leaflets seem at first to represent two species, the one (fig. 5) having, by its shape and size, an appearance different from that of the smaller. But, in closely comparing them, the same characters are recognized in all; the lower lateral nerves of fig. 7 are branched, like those of fig. 5; both have short marginal veinlets under the basilar pair of nerves, and, except for fig. 6, the divisions of the borders are simple and identical; this fig. 6, there-

fore, is the only one which might be described separately. As it was found in specimens from the same locality, as also its lateral veins, mostly opposite, have the same angle of divergence, are straight in passing to the borders, and craspedodrome, it seems really to represent a leaflet of the same species. Fig. 5, with a longer petiole, is apparently the terminal leaflet of a compound leaf; the smaller are the lateral ones. But it is not evident if the subdivision of the leaf is tripalmate or pinnate. The comparatively large number of small leaflets rather indicates their relation to a pinnate leaf. This species is comparable to *Rhus Pyrrhæ*, differing by its nerves running straight to the borders and directly entering the teeth, which, moreover, are much larger in the European species. The specimen represented in fig. 4 of pl. l is a narrower leaflet, apparently referable to this species.

HABITAT.—Evanston, Wyoming. The specimen of this last figure is from Middle Park, Colorado (*Dr. F. V. Hayden*).

Rhus membranacea, Lesqx.

Plate LXIV, Figs. 6, 7.

Rhus membranacea, Lesqx., Annual Report, 1874, p. 306.

Leaves ternate; leaflets membranaceous, oblong, or the lateral ones broadly oval, obtusely pointed rounded or subtruncate to a short petiole, irregularly coarsely duplicato-dentate; lateral nerves open, craspedodrome, more or less ramified, the lowest ones curving downward in joining the midrib.

The specimens represent one leaflet entirely preserved, longer and narrower, like the terminal one of a ternate leaf, and part of a lateral one, shorter and broader. The first, two and a half centimeters long, including the petiole (three millimeters), is oblong, with borders cut from the base in comparatively large, obtusely pointed teeth, either simple or with smaller protuberances upon the back; the nervation is distinctly craspedodrome, the secondary veins passing up and scarcely curving to the point of the teeth, and irregularly obscurely dividing in thin branches, joined in the middle of the areas, constituting large, indistinct areolæ. By the form of the leaflets and the border divisions, this species is closely related to *R. Pyrrhæ*, Ung., as figured by Heer (Fl. Tert. Helv., pl. cxxvi, figs. 20–28), whose leaves are round, truncate at the base, and broadly dentate, as in our fig. 7. Like *R. Pyrrhæ*, it is also comparable to *R. aromatica*, Ait., a common species of our present flora, widely distributed over the whole width of the United States, and whose leaflets, extremely variable, have also doubly dentate teeth, and, in the Southern States, a membranaceous consistence.

HABITAT.—Point of Rocks, Wyoming (*Dr. F. V. Hayden*).

Rhus pseudo-Meriani, sp. nov.

Plate LVIII, Fig. 11.

Leaves pinnately divided; leaflets oblong, gradually and slightly enlarged from the narrowed base to above the middle, dentate upward; lateral nerves very oblique, straight, subcamptodrome, connected with the teeth by nervilles.

By its shape and size, this leaflet is like those of *R. Meriani*, Heer (Fl. Tert. Helv., p. 82, pl. cxxvi, figs. 5–11). It is, however, dentate only near the point, and the nervation is not truly craspedodrome, the lateral nerves curving along the borders being connected with the teeth by nervilles. In the upper part of some of the leaflets represented by Heer (figs. 6 and 8, *loc. cit.*), the nervation seems of the same character, and in fig. 9, which resembles ours more than any other, the lower lateral nerves are truly camptodrome in the lower part, where the borders are entire, and in the upper part, at least on one side of the leaflets, the arches are connected with the teeth by nervilles. As I have for comparison the only specimen figured, it is not advisable to admit specific identity from a casual affinity which looks like a diversion of the general character. In this species, the secondary nerves, on an acute angle of divergence of 20° to 25°, are more distant in the lower part of the leaflet, very close toward or within the acumen. The substance is rather thick, membranaceous or subcoriaceous.

Habitat.—Black Buttes, Wyoming; above the main coal.

Rhus rosæfolia, Lesqx.

Plate XLII, Figs. 7–9.

Weinmannia rosæfolia, Lesqx., Annual Report, 1873, p. 415.

Leaf compound, imparipinnate, with three to four pairs of small, narrowly elliptical leaflets, obtusely pointed, rounded in narrowing to the sessile base, obscurely serrate in the upper part or entire; medial nerves thick, half-round; lateral nerves and areolation obsolete; rachis narrowly margined.

The dentation of the leaflets is not very distinct; some detached ones, apparently the lower, seen upon the same specimens, are smaller, and have the borders very entire (figs. 8 and 9). I referred this leaf to *Weinmannia* on account of the likeness of these remains to living species of this genus figured in Ett. Fl. v. Bil., i, pl. xxiii, figs. B, C. Count Saporta considers it as probably representing a species of *Rhus*, and I am the more disposed to admit his opinion, because remains of *Rhus* abound in the Upper Miocene flora of the Parks, where this plant has been found, while none of the central and tropical vegetable types have been recognized there. Indeed, the presence of species of *Weinmannia*, a genus especially dis-

tributed in the flora of South America and of New Zealand, would be an anomaly in that of the upper group of the Lignitic.

HABITAT.—West of Florissant, near South Park, Colorado, with *Ilex subdenticulata*, *Myrica acuminata*, *Sequoia Langsdorffii*, *Sapindus angustifolius*, etc. (*Dr. A. C. Peale*).

Rhus Haydenii, Lesqx.

Plate LVIII, Fig. 12.

Rhus Haydenii, Lesqx., Annual Report, 1873, p. 417.

Leaves pinnately divided into alternate, linear, or narrowly lanceolate, acute leaflets, entire or undulate, oblique, and slightly decurring to a broadly alate rachis; nervation pinnate, camptodrome.

The fragment, about five centimeters long, representing the upper part of a compound leaf, has a winged rachis, three millimeters wide on each side of the narrow midrib, with three pairs of alternate leaflets, four to six millimeters broad, two and a half centimeters long, narrowly oblong-lanceolate, obtusely pointed, nearly at right angle to the main rachis, to which they are united in a sinus acute in the upper side, and passing downward in a curve to the borders which descend parallel to the midrib. The camptodrome nervation is of the same type as that of *R. copallina*, Linn. The alar tissue of the rachis is also marked in this living species by parallel camptodrome veinlets forking near the point, as in the fossil species.

HABITAT.—Middle Park, Colorado (*Dr. F. V. Hayden*).

ZANTHOXYLEÆ.

ZANTHOXYLON, Linn.

Zanthoxylon juglandinum?, Al. Br.

Plate LVIII, Fig. 10.

Zanthoxylon juglandinum, Al. Br., Stizenb. Verz., p. 87.—Heer, Fl. Tert. Helv., iii, p. 86, pl. cxxvii, figs. 22–25, and cliv, fig. 36.

Leaflet broadly oval, distantly crenate; nervation camptodrome.

This fragment is too incomplete for satisfactory identification. The broadly oval form of the small leaflet and the character of the nervation relate it to the European Miocene species quoted above. The curves of the lateral nerves, however, are nearer to the borders, and the nervilles are more distinct and less divided in our fragment.

HABITAT.—Washakie group, Wyoming (*Dr. F. V. Hayden*).

AILANTHUS, Desf.

I have not seen any fragments representing this genus in the specimens from the Rocky Mountain Lignitic. Those, however, sent from Oregon have a quantity of winged seeds referable to some of its species.

CALYCIFLORÆ.

HALORAGEÆ.

TRAPA, Linn.

Trapa? microphylla, Lesqx.

Plate LXI, Figs. 16–17 *a*.

Trapa? microphylla, Lesqx., Annual Report, 1874, p. 304.

Leaves small, round or broadly oval and obtuse, rounded to the petiole; borders denticulate from below the middle upward; nervation ternate from the top of the petiole, or irregularly pinnate; lateral veins at an acute angle of divergence, 15° to 20°, flexuous, with dichotomous branches, all craspedodrome; areolation distinct, polygonal, minute, by subdivisions of the veinlets at right angle.

These leaves, represented in numerous specimens, vary in size from a little more than one centimeter long, and nearly as large, to about two and a half centimeters long and nearly two broad. They are generally oval, very obtuse, and somewhat enlarged upward; the borders are minutely dentate except at or near the base, rounded to a comparatively long and slender petiole, the only one of the leaves where it is preserved, not even to its base, being eighteen millimeters long and the petiole nine millimeters. The areolation is clearly defined, in very small square or polygonal meshes, formed by close, thick nervilles anastomosing with veinlets parallel to the nerves and their divisions, the parietes being as thick as the veins. The same kind of nervation is observable upon the lower surface of the leaves of the living *Trapa natans*, Linn., which, though comparable to these fossil ones, have the borders deeply toothed, and are of a much thicker texture. In this species, the leaves appear as membranaceous and pellucid, for the nervation and areolation seem as drawn in black upon the yellowish substance of the laminæ.

No fossil leaves published as yet are to my knowledge comparable to these, except those described by Prof Newberry, in the Report of the Colorado Exploring Expedition by Lieut. J. C. Ives, p. 131, pl. iii, fig. 5, under the name of *Neuropteris angulata*. The general form of the slightly dentate leaves and the remarkably acute angle of divergence of the secondary nerves are the same; even the irregular, though too obscurely marked, divisions of the lateral veins seem to be of the same character. It may be remarked, as a kind of confirmation of the reference of these leaves to *Trapa*, that Prof. J. W. Dawson has observed and described a fruit of this genus, found in connection with his *Lemna scutata*, from deposits identical by lithological characters and geological station to those of Point of Rocks.

HABITAT.—Lower Eocene strata of the Lignitic at Point of Rocks, Wyoming (*Dr. F. V. Hayden*); also seen upon the specimens communicated from the same locality by *Mr. Wm. Cleburn*.

MYRTIFLORÆ.

MYRTACEÆ.

Of this family, of which a large part of the present flora of New Holland is composed, we have only two species whose characters seem related to those of the genus *Eucalyptus*, as represented by fossil remains. They do not appear, however, satisfactorily identified.

EUCALYPTUS, L'Hérit.

Eucalyptus Hæringiana?, Ett.

Plate LIX, Fig. 10.

Eucalyptus Hæringiana, Ett., Här. Foss. Fl., p. 84, pl. xxviii, figs. 2–25.—Heer, Flor. v. Börnst., p. 19, pl. iv, fig. 14.

Eucalyptus Hæringiana ?, Lesqx., Annual Report, 1872, p. 400.

Leaves linear-lanceolate to the point and to the slightly inequilateral base; secondary nerves alternate, mostly simple, ascending to the point, parallel to the midrib.

If some of the leaves figured by the author of the Flora of Bilin have the same form and size as these, that one represented by Heer in the Börnstaedt Flora differs by its characters, form, and nervation. I am therefore now more uncertain in regard to the relation of this species than when I described it *loc. cit.*, when this Börnstaedt Flora was still unknown to me. The nervation is somewhat like that of *Grevillea* species; for example, *G. provincialis*, Sap. (Ét., i, p. 99, pl. viii, fig. 3), and still more like that of some *Mimosæ: Prosopsis*, etc.

HABITAT.—Black Buttes, Wyoming, in red baked shale

Eucalyptus ?Americana, Lesqx.

Plate LIX, Figs. 11, 12.

Eucalyptus Americana, Lesqx., Supplement to Annual Report, 1871, p. 7.

Leaves subcoriaceous, very entire, narrowly lanceolate, gradually tapering upward from below the middle into a long, narrow acumen, narrowed in the same degree to the base, sessile; middle nerve thick, enlarged at the point of attachment; lateral nerves oblique, straight to near the borders, where they join a continuous marginal vein.

These fine leaves have the nervation and shape of species of this genus. They are comparable, for the nervation at least, to *E. oceanica*, Ung., as figured by Heer (Flor. Tert. Helv., pl. cliv, fig. 14). In this figure, the lateral nerves are more open; but, in the species represented by the leaves of the Baltic Flora of the same author, they are more oblique than in those described here. Since 1871, the time when they were first considered, I have obtained

a number of living species from Cuba. Some of these, especially of the family of the *Euphorbiaceæ*, *Tricera retusa*, Gray, *T. fasciculosa*, Gris., have a nervation and a texture of leaves exactly corresponding with those of the specimens of Green River, and I now should be disposed to rather refer them to this genus, or at least to the *Euphorbiaceæ*, abundant in the subtropical North American flora, than to Australian types; for this *Eucalyptus* would be, like the former, an anomaly in the Upper Tertiary flora of the Lignitic. As in species of *Tricera*, the leaves are very short-petioled, attached to the stems merely, as far as can be seen from the specimen, by the enlarged base of the flat, broad midrib; the lateral veins, at an angle of divergence of 40°, pass straight to the borders, where they join, with scarcely any curve, a distinct marginal nerve, somewhat thinner than the veins. This apparent marginal nerve is of course formed by the abrupt curve of the lateral nerves which follow the borders, as more distinctly marked in fig. 11. In *Tricera retusa*, we see exactly the same character, which is observable also in the distribution of the numerous parallel secondary nerves, separated by thinner and shorter tertiary veins, joined either in right angle by nervilles or in very acute angle by branchlets coming out from the midrib or from the lateral nerves. From the fragments figured here, the leaves seem to be comparatively very long, for fig. 11 is twelve centimeters long and fifteen millimeters broad; and, by comparison, the fragment represented in fig. 12, which is more than one-third broader, should be part of a leaf about eighteen centimeters long.

HABITAT.—Green River group, Wyoming, above fish-beds (*Dr. F. V. Hayden*).

ROSIFLORÆ.

POMACEÆ.

Of the presence of plants of this family in our Tertiary flora, we have as yet no positive evidence, the fragments described here as *Cratægus* being too incomplete for positive identification.

CRATÆGUS, Linn.

Cratægus? æquidentata, sp. nov.

Plate LVIII, Figs. 4, 4 *a*.

Leaves of large size, broadly lanceolate; borders dentate; nervation craspedodrome.

These fragments have the nervation of leaves of *Cratægus*, the lateral nerves about equidistant and parallel, the lower branching outside, and the

number of the divisions decreasing toward the point where the nerves have still one or two branches, as in the living *C. pyracantha*, *crus-galli*, *flava*, etc. The areolation is not discernible. Though the simple nervilles are not a character of this genus, nor the obtuse equal teeth, these leaves have an evident relation to *C. antiqua*, Heer (Fl. Arct., i, p. 125, pl. l, figs. 1, 2), two leaves which have, like our fragments, the lower lateral nerves with many branches, the upper being less divided, and only toward the borders; all joined in right angle by strong, distant, simple fibrillæ. The Greenland leaves differ much, however, by straight, more oblique, lateral nerves and the acute teeth of the borders.

HABITAT.—Carbon, Wyoming.

LEGUMINOSÆ.

Of this class of plants, we have also in the Lignitic flora very few representatives, though the North American flora of the present time has a large number of its species. More than three hundred fossil ones are described from the Tertiary of Europe; most of them from the Miocene of Oeningen; a few from the Armissan of France. Five only, of doubtful attribution, are referred to the Eocene of Mount Bolca and of Alum Bay.

PODOGONIUM, Heer.

This genus is established by the author from a large number of specimens, especially found in the upper strata of Oeningen, and is beautifully illustrated by leaves and fruits in his Fl. Tert. Helv. With the leaves described under this generic name, I have found only a fragment of a capsule, which is probably referable to it.

Podogonium Americanum, sp. nov.

Plate LIX, Fig. 5; Plate LXIII, fig. 5; Plate LXV, fig. 6.

Podogonium species, Lesqx., Annual Report, 1873, p. 417.

Leaves small, lanceolate, acuminate, narrowed to the short petiole; lateral nerves numerous, parallel.

These leaflets are all of the same form and size, four centimeters long, a little more than one centimeter broad in the middle, narrowed in the same degree upward to a sharply pointed, comparatively long, acumen, and downward to a short but distinct petiole. The lateral nerves are close, fourteen to seventeen pairs, diverging in an angle of 40°, either simple or intermixed, with

shorter tertiary veins anastomosed by nervilles in right angle. This nervation is typically identical with that of *P. Knorrii*, Heer (Fl. Tert. Helv., iii, p. 114, pl. cxxxiv, figs. 22–26; cxxxv; cxxxvi, figs. 1–9); the leaflets of our pl. lix, fig. 5, and pl. lxiii, fig. 2, corresponding to fig. 4, pl. cxxxvi, and that of our pl. lxv, fig. 5, to fig. 3 of the same plate of Heer. The shape of the leaflets and their size, though comparable also to those of *P. Knorrii*, differ by the longer, sharply pointed acumen, and by the longer slender petiole not inflated at its point of union to the middle nerve. The fragment of capsule, described in Annual Report, 1873, p. 417, as referable to a *Podogonium* species, is pedicellate, apparently oval, but broken below the middle, and cannot be specifically identified. It may represent the same species.

HABITAT.—The first of the specimens is from Black Buttes, Wyoming; the second (pl. lxiii), from Middle Park, Colorado (*Dr. F. V. Hayden*), with the broken capsule; the third (pl. lxv), from near the mouth of White River, Green River group, Wyoming (*Prof. W. Denton*).

CASSIA, Linn.

Cassia concinna?, Heer.

Plate LIX, Figs. 8, 8 *a* (enlarged).

Cassia concinna, Heer, Fl. Tert. Helv., iii, p. 122, pl. cxxxviii, fig. 41.—Lesqx., Annual Report, 1872, p. 402.

This fragment of an unfolding leaflet is like the undeveloped ones figured by Heer, *loc. cit.*; the middle or dorsal nerve is thick and the lamina folded along the lateral nerves. As we have a single leaflet for comparison, this similarity is not sufficient for identification.

HABITAT.—Evanston, Wyoming.

ACACIA, Neck.

Acacia septentrionalis, Lesqx.

Plate LIX, Figs. 9, 9 *a* (enlarged).

Acacia septentrionalis, Lesqx., Annual Report, 1873, p. 418.

Leaflet small, coriaceous, oblanceolate, rounded to a very short point, gradually tapering downward to the short petiole; nervation pinnate, acrodrome.

This small leaflet, two and a half centimeters long, and four millimeters broad toward the rounded point, has the lateral nerves alternate, ascending nearly parallel to the midrib, the upper one reaching the point in an inside curve, all anastomosing in oblique veinlets, composing long equilateral meshes; these veins are very thin, discernible only with a strong glass; the surface is

rough. The relation of this leaflet to the one described by Heer as *A. rigida* (Fl. Tert. Helv., iii, p. 133, pl. cxl, fig. 22) is evident The hard texture of the leaflets and their nervation are the same: they merely differ by the shape.

HABITAT.—Near Castello's Ranch, Colorado (*Dr. F. V. Hayden*).

MIMOSITES, Ett.

Mimosites linearifolius, Lesqx.

Plate LIX, Fig. 7.

Cæsalpinia linearis?, Lesqx., Annual Report, 1873, p. 417.

Leaf imparipinnate; leaflets opposite, close, small, linear, abruptly pointed, falcate upward, rounded at the point of attachment to the narrow common pedicel; nervation obsolete.

The fragment, the upper part of a leaf, has seven pairs of leaflets on a length of two and a half centimeters. These leaflets appear of a somewhat thick texture, as every trace of nerve, even of the middle one, is concealed. They are narrow, only two millimeters broad, the lowest one and a half millimeters long, nearly linear, oblique, rapidly pointed, and curved upward near the point, sessile by a rounded base. This species is evidently related to the *Mimosæ* rather than to the *Leguminosæ*. It has especially a marked degree of relation to *Pithecolobium dulce*, Mart, a living species of Brazil, whose leaflets, of the same form and size, scythe-shaped toward the point, have a very thin nervation, and are sessile and rounded to the base.

HABITAT.—Florissant, near South Park, Colorado (*Prof. E. D. Cope*).

LEGUMINOSITES, Brgt.

Leguminosites cassioides, sp. nov.

Plate LIX, Figs. 1–4.

Leaflets oblong, rounded in narrowing to a short petiole, apparently lanceolate to a point; lateral veins curved, reaching close to the borders; areolation small, subquadrate from subdivisions of distinct nervilles in right angle to the nerves.

These leaflets are comparable to those of species of *Cassia;* for the shape and the nervation, especially to *C. berenices*, Ung. (in Heer's Fl. Tert. Helv., iii, p. 118, pl. cxxxvii, figs. 42–56). The nervilles in right angle to the nerves are, however, not distinctly marked in this European Miocene species. Our fig. 3 has the inequilateral form, and the lateral nerves branching as in *C. phaseolites*, Ung. (in Heer, *loc. cit.*, p. 119, pl. cxxxviii, fig. 7). The attribution of this last species is doubtful, according to Schimper.

HABITAT.—The three first figures are from specimens from Green River, Wyoming, above fish-bed (*Dr. F. V. Hayden*); the fourth from Spring Cañon, near Fort Ellis, Montana (*Jos. Savage*).

Leguminosites? arachioides, Lesqx.

Plate LIX, Figs. 13, 14.

Carpolithes arachioides, Lesqx., Annual Report, 1872, p. 403.

Capsules or siliques alternate and sessile, on flexuous, thick, woody pedicels; obovate, rounded to a short acumen, mostly enlarged on the lower side, bossed under the point as inclosing a round seed, regularly striated with narrow ridges, generally tending in a curve from the borders to the point, obscurely and transversely wrinkled.

These capsules, or pods, are turned upward in the upper part of the branches, horizontal or pending in the lower part, two and a half centimeters long, one centimeter broad in the middle, flattened by compression, but generally convex or inflated near the point, as from the presence of an inside, large, round seed; narrowed in curving to a very short, broad, petiole. The relation of these racemes of fructification is as yet uncertain; they seem to belong to the *Leguminosæ*, especially resembling branches bearing fruits of our *Arachis hypogæa*, Linn., the Ground-nuts of the South. But they do not bear at the base any trace of remains of the calyx or receptacle, which, in the species of this family, is scarcely absent except perhaps in the fructifications of some *Sclerolobium*, *Cenostigma*, etc. Fig. 14, left side, has the pedicel attenuated and elongated as part of a broken tendril.

HABITAT.—Evanston, Wyoming; in a block of iron-stone taken out from the mines. No leaves or any other vegetable remains were recognizable but these. The fruits appear of a hard, woody consistence.

INCERTÆ SEDIS.

PHYLLITES, St.

Phyllites Sapindiformis, sp. nov.

Plate XXIX, Figs. 6, 7.

Leaves small, linear, subfalcate, entire, narrowed to an inequilateral base, pointed or acuminate; lateral nerves close, parallel, camptodrome, separated by short tertiary ones.

These two fragments of leaves, mixed upon the same specimens with those of *Ficus arenacea*, cannot be referable to this species, though they have some characters in common: the thick consistence, the entire borders, and the inequilateral base. The upper part of these leaves is destroyed; they seem to be acuminate and somewhat turned to one side, like leaves of *Sapindus*. They are also related to this genus by their nervation. The relation is, however, distant, not more definite than with some *Leguminosæ: Cassia*, *Podogonium*, etc.

HABITAT.—Green River group, Wyoming (*Dr. F. V. Hayden*).

CARPITES, Schp.

Prof. Schimper, in his *Paléontologie Végétale*, proposes and admits the name of *Carpites* as a distinction for the fruits and seeds of dicotyledonous species from those of the Carboniferous. This distinction seems right, in order at least to reduce the very numerous specific names appended until now to the name of *Carpolithes*.

Carpites lineatus?, Newby.

Plate LX, Figs. 1–1 *d*.

Carpolithes lineatus, Newby., Notes on the Later Ext. Fl., p. 31.—Lesqx., Annual Report, 1871, p. 295.

Fruits nearly globular, slightly pointed, irregularly thinly striated in the length.

Prof. Newberry has given this name to a fruit figured in the plates of the Miocene flora of Fort Union, but not described. It is a little smaller than those of Evanston, but has the same characters. These, nearly two centimeters in size, much resemble hazel-nuts, and could be referable to *Corylus*, but for their thinner, shelly envelope. By this character, they are related to the fruits of some Palms, though the epicarp is twice as thick as in those described (pl. xi and xiii). As no Palm leaves have been found at Evanston, where these nuts are very abundant, and none either of *Corylus*, their relation is as yet unascertained.

Habitat.—Evanston, Wyoming; above coal (*Dr. A. C. Peale*).

Carpites oviformis, sp. nov.

Plate XXX, Fig. 6 *a*.

Fruit exactly ovoid, ten millimeters long, six broad in the middle.

This small nut is apparently a hard drupe, as it is not flattened by compression. Its surface is neither striate nor lineate, but somewhat rough. It is much like the fruit of *Prunus Scottii*, Heer, figured in Arct. Fl., i, pl. viii, fig. 15 *a*, only more obtuse.

Habitat.—Golden, Colorado.

Carpites triangulosus, sp. nov.

Plate LX, Fig. 4; Plate LXII, Figs. 19, 20.

Drupes small, triangular, obtuse, eight to ten millimeters long, four to six broad below the middle, grooved by a deep middle line from the point to the base, smooth or indistinctly lined.

I consider figs. 19 and 20 as a small variety, or perhaps a different species, of the same generic division. These drupes resemble those of a *Prunus*, but are much smaller.

HABITAT.—Golden, Colorado, the specimen represented in fig. 4; the others from Point of Rocks (*Wm. Cleburn*).

Carpites costatus, sp. nov.

Plate LX, Fig. 5.

A fragment of a drupe buried in the stone, and of which the figured part only could be seen. It shows the point of attachment, originally round, but of an oval form by compression, surrounded by a double ring, with flat prominent costæ passing downward; the surface between the ribs is smooth.

HABITAT.—South Table Mountain, near Golden, Colorado.

Carpites coffeæformis, sp. nov.

Plate LX, Figs. 6, 7.

The two parts figured seem to represent each a half drupe separated by disjunction in the middle; they are oval-oblong, obtuse above, truncate in the lower part, deeply grooved in the middle. One of the specimens shows, totally imbedded into the stone, a cavity divided into five cells, by sections or dissepiments, which are not joined to the central column. The flat surfaces represented in the figures look like two ovules of the same fruit, joined in their length. They may be referable to the former fragment (fig. 5).

HABITAT.—Golden, Colorado.

Carpites myricarum, sp. nov.

Plate LX, Figs. 8–11.

Small, round-oval seeds, five millimeters in diameter, slightly pointed upward, round or truncate at the base. They resemble large seeds of *Myrica*. Fig. 11 appears like a scale of a cone. These seeds are slightly flattened, obscurely striate longitudinally.

HABITAT.—Black Buttes, Wyoming; in connection with the leaves of *Myrica Torreyi*, and not rare, but always sparse.

Carpites rostellatus, sp. nov

Plate LX, Figs. 12, 13.

Hard-shelled small fruits, from six to ten millimeters in size, rounded on one side, pointed-rostellate on the other, with three narrow ribs passing down, and at equal distances from the point to near the base, where they

become effaced. The small specimen represented in fig. 13 is loosened from the stone, in part, at least, and appears filled with a dry irregularly wrinkled ovule half decayed.

HABITAT.—Golden, Colorado.

Carpites glumæformis, sp. nov.

Plate XXXV, Fig. 4 *d*; Plate LX, Figs. 14–17.

Seeds(?) obovate or oblong, rounded and enlarged on one side, narrowed on the other to a point or a pedicel, one to one and a half centimeters long and five to six millimeters broad, distinctly striate in the length. These fruits are not rare, always immersed into the stone, convex, or half-flattened. They resemble large glumes. Fig. 4 *d* of pl. xxxv and fig. 14 of pl. lx seem narrowed into a pedicel, and are slightly scythe-shaped.

HABITAT.—Black Buttes, Wyoming, common. Evanston, Wyoming, rare.

Carpites mitratus, sp. nov.

Plate LX, Figs. 18, 19.

The composition of these vegetable organs is not well ascertained. They appear like wings of a small, round carpel attached at the base. The wings are broadly cordate, obtuse; the one in fig. 18 surrounded by a flat border. The carpel is inflated and of about the same form. Its position at the base of the wing may be casual, this being perhaps an inflated pod from which the carpel has been expelled or detached by compression.

HABITAT.—Black Buttes, Wyoming.

Carpites laurineus, sp. nov.

Plate LX, Figs. 20, 21.

Berries small, nearly round, short-pointed, about five millimeters in diameter, surrounded by a thin, shelly epicarp. They closely resemble the fruits of *Tetranthera sessiliflora* (pl. xxxv, figs. 8 *c* and *d*), and especially those of pl. xxxiv, fig. 1 *c*. They may represent the same species, for they merely differ by their shape, which is rather round than oval, and by their smaller size. They are from the same locality.

HABITAT.—Evanston, Wyoming.

Carpites Utahensis, sp. nov.

Plate LX, Fig. 22.

Fruit small, broadly obovate, cordate or emarginate at one end, rounded to a short point at the other, smooth, bearing remains of a thin epicarp. It is one centimeter long, and seven millimeters broad toward the point.

HABITAT.—Evanston, Wyoming.

Carpites verrucosus, sp. nov.

Plate LX, Fig. 23.

Fruit nearly round, one centimeter across, emarginate in the lower part at its point of attachment to a short broken pedicel; surface flat, covered with small obtuse warts. This seed is like the flattened drupe of a *Magnolia*. In the living *M. grandiflora*, the base of the seed is cut or emarginate as in this one, and generally has its short pedicel attached to it. This seed is surrounded by a flat margin, which may be the borders of a flattened pericarp.

HABITAT.—Black Buttes, Wyoming, Saurian bed; represented by three specimens.

Carpites minutulus, sp. nov.

Plate LX, Fig. 25.

Seeds very small, three millimeters long, only half as broad, inflated and rounded at one end, gradually narrowed to a short acumen, smooth. It resembles by its size and form *C. læviusculus*, Heer (Fl. Spitz., pl. xv, fig. 47). It is mixed with fragments of stems and branches which appear to belong to some Conifers, but crushed and unidentifiable.

HABITAT.—South Table Mountain, near Golden, Colorado.

Carpites Viburni, sp. nov.

Plate LX, Figs. 26, 26 *a*.

Fruit small, ovoid, obtuse, short-pediceled, six to seven millimeters in diameter, covered with a thin, flattened pericarp. It is apparently a seed of *Viburnum*, like some of those of fig. 2 of the same plate. It is, however, from a different locality.

HABITAT.—Black Buttes, Wyoming, where leaves of *Viburnum* species are very abundant.

Carpites spiralis, Lesqx.

Plate LX, Fig. 27.

Carpolithes spiralis, Lesqx., Supplement to Annual Report, 1871, p. 16.

A large, apparently hard fruit, four and a half centimeters long, nearly three centimeters broad in the upper part, obovate, rounded, gradually narrowed downward to its lower end, where it is broken and still seventeen millimeters broad, deeply furrowed in spiral lines passing downward from the upper border, and strangled horizontally above its base by two strong lines cutting the spiral ribs without changing their direction. This fruit has some likeness of form, especially by its spiral or oblique costæ, to the nut of *Torreya Californica*.

Habitat.—Placière Mountain, anthracite beds, New Mexico (*Dr. F. V. Hayden*).

Carpites rhomboidalis, sp. nov.

Plate LX, Figs. 28, 29.

Pods(?) square or rhomboidal in outline, flattened at the borders, inflated in the middle, twelve millimeters in diameter. They look like a one-seeded legumen. Fig. 28 seems to bear inside, and in a mature state, a seed which is nearly exactly ovate-acute. Fig. 23 appears empty or immature.

Habitat.—South Table Mountain, near Golden, Colorado.

Carpites bursæformis, sp. nov.

Plate LX, Fig. 30.

Fruit apparently hard, not flattened, covered with a thin, shelly pericarp, fifteen millimeters long, eight millimeters broad below the middle, narrowed at one end into a flattened truncate point, rounded and inflated at the other, resembling a small bladder with its collum. The lower part is marked by a few distant, obscure, and narrow ribs.

Habitat.—Black Buttes, Wyoming; above main coal.

Carpites Pealei, sp. nov.

Plate LX, Fig. 31.

Fruit narrowly elliptical or oblong, flattened, rounded on one side, pointed at the other, two centimeters long, five to six millimeters broad, marked from the rounded part to below the middle by small parallel striæ.

Habitat.—Florissant, near South Park, Colorado (*Dr. A. C. Peale*).

Carpites cocculoides?, Heer.

Plate LX, Figs. 32–35.

Carpolithes cocculoides, Heer, Fl. Arct., ii, p. 484, pl. lii, fig. 9.—Lesqx., Annual Report, 1871, p. 290.

Fruits small, one centimeter long, six millimeters broad in the enlarged upper part, obovate, sessile, obliquely truncate at the point of attachment, regularly more or less distinctly striate in the length. It represents evidently a hard drupe, as the stone is excavated wherever this fruit has been imbedded. It turns on one side to a point more distinctly than it is marked in Heer's figures of this species (*loc. cit.*), but this may be an appearance resulting from its position in the stone. Though abundant enough, especially at Carbon, I have never seen it attached to a pedicel.

HABITAT.—Carbon, Wyoming (*Dr. F. V. Hayden*).

Carpites cocculoides?, Heer, var. major.

Plate LX, Figs. 38, 39.

Merely differs from the former by its size, being doubly laıger. It is apparently referable to a different species of the same genus. Heer compares these fruits to the seeds of *Menispermum* or *Cocculus*, which they much resemble, indeed.

HABITAT.—I found these specimens at Carbon, with a number of those of the former size.

Carpites ligatus, Lesqx.

Plate LX, Figs. 36, 36 *a*.

Small, narrowly oval fruits or drupes, seemingly joined at the base. They are of a hard consistence, not flattened, and thinly striated in the length. The only specimen seen represents four of these drupes(?) imbedded at the base into the stone.

HABITAT.—Placière Mountain, New Mexico (*Dr. F. V. Hayden*).

Carpites valvatus, sp. nov.

Plate LX, Fig. 37.

A mere fragment, representing apparently the outside part of a valvate receptacle. It is a little more than one centimeter long, and as broad, enlarged upward and fan-like from a broken base, divided outside into six oblanceolate, obtuse, convex ribs, with a smooth, rounded top above. Fragments of this kind, but more obscure still, are found in the bottom clay of the Lignitic coal, near Fort Steele, Wyoming (*F. B. Meek*), with *Abietites dubius*. They resemble the capsules of *Nordenskiöldia borealis* as figured by Heer (Spitz. Fl., pl. vii, fig. 7).

PART III.

THE AGE OF THE LIGNITIC FORMATIONS AS DETERMINED BY THE CHARACTERS OF THE FOSSIL PLANTS.

I have to meet at the beginning an objection which, if not refuted, might leave some doubt of the reliability of the conclusions which I have drawn from the characters of our fossil plants with regard to the evidence they afford upon the age of the formations from which they are derived.

This objection bears upon the uncertainty of some of the determinations of the plants which are described in this work, the references to which have, in a few cases, been modified, as may be seen by the synonymy presented with the species. I am the more inclined to take up the subject here, since this will afford me the opportunity of giving due credit to those who have contributed to the value of this memoir by communication of materials for examination, and also of acknowledging the assistance rendered by scientific friends interested in the progress of American paleo-botany.

The first specimens used for the preparation of the Fossil Flora of the Lignitic of the Western Territories were sent to me as early as 1867 by Dr. John L. Leconte, who gave a short account of these plants in his report (p. 39) and in a note (p. 50).* They had been mostly collected around the base of the Raton Mountains near Trinidad, and in Colorado. Though the specimens were few and more or less fragmentary, I could then, from those which were determinable, refer the Marshall's coal to the Lower Eocene. Soon after I received from Dr. F. V. Hayden a new lot of fossil leaves, some from the Laramie Plains, most of the others from Marshall's and Golden, and, after a short description of them in Dr. Hayden's Annual Report, 1869, p. 195, I concluded that the relation of the six species of Rock Creek was

* Notes on the Geology of the Survey for the Extension of the Union Pacific Railway, E. D., from the Smoky Hill River, Kansas, to the Rio Grande, by John L. LeConte, M. D. (1868.)

positively to Miocene plants of Europe. I therefore admitted the formation as Miocene, while those of Marshall's were representatives of an older Tertiary formation by their marked affinity to fossil plants which I had examined and described from the so-called Great Lignitic of Mississippi, a formation which I considered then as lowest Tertiary or Eocene. From that time, and each year, Dr. Hayden sent me, as collected either by himself or by members of his Survey, new lots of specimens, which were immediately studied, and briefly described in his Annual Reports from 1870 to 1874. At first, most of the specimens were incomplete; therefore the determination of the species was sometimes doubtful. Later, in 1872, following the instructions of Dr. Hayden, who wished me to study especially the flora of the Lignitic, its distribution, and its evidence in regard to the age of the measures, I visited the more important localities of the Western Territories where species of vegetable remains were obtainable: the Raton Mountains, Cañon City, the Colorado Basin, and, in Wyoming, Carbon, Black Buttes, Evanston, etc. I could there not only select more valuable materials, but study in place some of the species from the comparison of numerous fragments elucidating their characters. I had then the assistance of my son, Mr. L. Lesquereux, who greatly contributed to the abundance of our collections. In 1873, I revisited, by myself alone, the Colorado Basin, and the more important localities of the Bitter Creek series, adding considerably to the collections of fossil plants of the Geological Survey, and procuring at the same time the assistance of some gentlemen, who, becoming interested in vegetable paleontology, have since then furnished some very fine materials described in this volume. The first of all, Rev. Arthur Lakes, has continued his researches until now; his last communication, a lot of plants from the Lignitic and another from the Cretaceous of the Hogbacks of Colorado, came, to my regret, too late; and, though a few of the species which they represent could be described in this volume, it has not been possible to have them figured here. Then Col E. L Berthoud, also of Golden, sent, at different times, some good specimens of very rare plants, especially those of a *Selaginella*, which bears his name, and is the first species of this genus hitherto known from Tertiary formations.

When I visited Golden for the first time, I met there Mr. Wm. Cleburn, who had already collected specimens of fossil plants from divers localities along the Union Pacific Railroad. As soon as apprised of the purpose of

my visit, he entered at once with the greatest zeal into the work of explorations, and presented to the Survey all the materials of value discovered by our common researches in the country around Golden. It will be seen in the descriptions that he sent later, from Point of Rocks and from Alkali Station in Wyoming, a large lot of specimens, some of them representing new species of leaves in very good preservation. Other communications from the Lower Lignitic are due to Prof. F. B. Meek, and to Mr. Geo. Hadden, of Coal Creek, Colorado. From Fort Fetterman, Lieut. A. W. Vogdes sent two lots of fossil plants, mostly fragments of *Taxodium*, referable to the Laramie or third group. The specimens of Prof. E. D. Cope from the Upper Green River group, Castello's Ranch, Florissant, and Elko Station, represent, with those of Prof. Wm. Denton and Dr. F. V. Hayden himself, the largest part of the species described from this formation. A few specimens were also sent by Profs. J. A. Allen and S. W. Garman, and more recently by Prof. A. Brownell. These last were received after the preparation of the plates, and too late to be figured: but the new species which they represent have been described.

From the Lower Green River group, nearly all we know is derived from the specimens sent by Dr. Hayden, from above the fish-beds of Green River Station.

The members of the Geological Corps of the United States Survey of the Territories, Dr. A. C. Peale, A. R. Marvine, J. T. Gardner, W. H. Holmes, and Jos. Savage, have occasionally give their attention to the collection of fossil vegetable remains, and procured some valuable materials from localities out of the reach of private explorations. They were encouraged to do so by Dr. Hayden, who, in his expedition of 1875, obtained himself, from Point of Rocks and from the Parks, splendid materials, constituting an important contribution to the American Tertiary flora.

It may be unnecessary to state that the contribution of specimens of fossil plants, too often mere fragments, sent in small lots from separate and distant localities, continued for a series of years, and that the necessity of reporting on them for each Annual Report required repeated comparison and revisions of the first specifications. Therefore, the original determinations of species established from insufficient materials have, in some cases, been recognized as incorrect, and the names changed. And also, while the Flora was in course of preparation, I obtained the generous

assistance of Count Saporta, who, from the examination of the plates, and by the comparison of our species with European specimens, advised some modifications, which I readily accepted, and which, as seen in the descriptive part, have been credited to this celebrated paleontologist. This explains, for some of our species, a synonymy which may seem at first to be regretted; but for an American monograph, which, as the first on this subject, may be hereafter used as a basis for the comparative study of the flora of the Lignitic, the precision of the work, as far as it was obtainable in any possible way, had to be alone considered. And, certainly, the determination of our American species of fossil plants confirmed by Saporta, who is now the leading paleo-botanist of France and the successor of Brongniart, gives to this memoir a reliability which could not have been secured without the means furnished for comparative study by the immense collections of living and fossil plants of Europe.

Another objection is likely to be made against the mixed references of the fossil plants to the geological formations which they represent. The divisions could have been rendered more striking indeed by describing, in separate monographs, the species represented in each of the groups. I was at first disposed to prepare the work in this way; but, as will be seen by the examination of the distribution of the plants from the list given beyond, the relation of age of some of these groups is not positively ascertained; and I believe that the comparison of species made from the general exposition of the whole flora will serve to elucidate the question concerning those uncertain references. Indeed, as the specimens were sent to me in successive lots or series, which sometimes were not clearly defined in regard to their place of origin, I needed myself such a kind of general comparison of species, whose geological age was merely presumed, in order to fix my opinion about their real affinities. And also, as every year, at different times of the year, I have been, and am still, in receipt of specimens from distant localities, it became evident, from the first, that I should have to describe, too late for the arrangement of the plates, a number of species which could not be distributed according to the plan proposed. This is the case, for example, for the five last plates, made from specimens from Point of Rocks, Lower Eocene, from the Carbon, and from the Upper Green River group, that of the Parks. To obviate an apparent confusion, which may give, at first sight, in the examination of the plates, some uncertainty in regard

to the geological distribution of the plants, I have marked upon the pages of explanations, and after the name of each species, numbers indicating the geological divisions which they represent, while the table of distribution shows the localities from which the plants are derived and the groups to which they are referred.

This table of distribution will be easily understood. The references to species of geological groups, either European or American, are not equally precise. They are marked by the note of interrogation (?), or by the exclamation point (!), according to the degree of relation or of identity, both being either positive or more or less indefinite.

TABLE OF DISTRIBUTION OF THE SPECIES OF THE TERTIARY FLORA.

	Names of species.	First Group.	Second Group.	Third Group.	Fourth Group.		Cretaceous.	Eocene.		American Miocene—Alaska, Fort Union: European Miocene.	Present flora.
		Raton Mountains, Placiere, Cañon City, Golden, Marshall's, Erie, Sand Creek, Henry's Fork, Fort Ellis and Spring Cañon, Black Buttes, Alkali Station, Point of Rocks, Yellowstone Lake.	Evanston, Mount Brosse, Troublesome Creek, Bridger's Pass.	Carbon, Rock Creek, Washakie, Medicine Bow, Fort Fetterman, eight miles southeast of Green River Station.	Lower Green River. Barrell's Springs, Green River Station above fish-beds, Sage Creek.	Upper Green River. Florissant, Castello's Ranch, Elko, mouth of White River.		America—Mississippi, Vancouver.	Europe—Sézanne, Mount Bolca, etc.		
	CRYPTOGAMÆ.										
	FUNGI.										
1	Spheria lapidea, Lx	R									
2	Spheria myricæ, Lx	B. B			G. R						
3	Spheria rhytismoides, Lx	B. B									
4	Sclerotium rubellum, Lx	G									
	LICHENES.										
5	Opegrapha antiqua, Lx	B. B									Rel.
	ALGÆ.										
6	Halimenites striatus, Lx	R									
7	Halimenites major, Lx	R., G., B. B., F. E		C			Rel.		E. Rel.!		
8	Halimenites minor?, F. O	R., G							E. Rel.!		
9	Delesseria fulva, Lx	G							E. Rel.!		Rel.
10	Caulerpites incrassatus, Lx	R., G									
11	Chondrites subsimplex, Lx	R									
12	Chondrites bulbosus, Lx	R									
13	Fucus lignitum, Lx	P. of R								Rel.	Rel.!
	MUSCI.										
14	Hypnum Haydenii, Lx					C					Rel.!
	LYCOPODIACEÆ.										
15	Lycopodium prominens, Lx					E					

16	Selaginella Berthoudi, Lx	G									Rel. !
17	Selaginella falcata, Lx	P. of R.									
18	Selaginella laciniata, Lx	P. of R.									
	FILICES.										
19	Sphenopteris Lakesii, Lx	G							S. !		
20	Sphenopteris membranacea, Lx	G							S. !	Id. ?	
21	Sphenopteris nigricans, Lx	G., B. B.							Rel. !	Rel	
22	Hymenophyllum confusum, Lx	G									Rel. ?
23	Pteris pseudo-pennæformis, Lx	Hy. F.								Rel. !	
24	Pteris subsimplex, Lx	G									Rel. ?
25	Pteris erosa, Lx	R., G.								Rel	
26	Woodwardia latiloba, Lx	G									
27	Woodwardia latiloba, minor, Lx	B. B.								Rel. !	
28	Diplazium Muelleri ?, H	Hy. F								Id. ?	
29	Lastrea Goldiana, Lx	G								Rel.	
30	Lastrea intermedia, Lx	G., Hy. F.								Id. ?	
31	Lastrea polypodioides ?, Ett	S. Cr.								Id. ?	
32	Gymnogramma Gardneri, Lx	S. Cr.							Id. !		
33	Gymnogramma Haydenii, Lx	F. E., Y. S.									Rel.
34	Osmunda affinis, Lx	G									
35	Lygodium neuropteroides, Lx				B. S.						
36	Lygodium Marvinei, Lx	Gypsum series									
37	Lygodium Dentoni, Lx					W. R.					
38	Lygodium compactum, Lx	M.									
	RHIZOCARPÆ.										
	Salviniea.										
39	Salvinia cyclophylla, Lx					Fl.				Rel	
40	Salvinia Alleni, Lx					C.				Rel. !	
41	Salvinia attenuata, Lx	P. of R.								Rel. !	
	CALAMARLÆ.										
	Equiseteæ.										
42	Equisetum Haydenii, Lx			C.	B. S.					Rel. !	
43	Equisetum lævigatum, Lx	S. Cr., G.									
44	Equisetum Wyomingense, Lx				G. R.						
45	Equisetum limosum, Linn					Y. S., lava					Id.
	PHÆNOGAMÆ.										
	GYMNOSPERMÆ.										
	Zamiæ.										
46	Zamiostrobus mirabilis, Lx	G								Rel. ?	

Table of distribution of the species of the Tertiary flora—Continued.

	Names of species.	First Group.	Second Group.	Third Group.	Fourth Group. Lower Green River.	Fourth Group. Upper Green River.		Eocene.			
		Raton Mountains, Placière, Cañon City, Golden, Marshall's, Erie, Sand Creek, Henry's Fork, Fort Ellis and Spring Cañon, Black Buttes, Alkali Station, Point of Rocks, Yellowstone Lake.	Evanston, Mount Brosse, Troublesome Creek, Bridger's Pass.	Carbon, Rock Creek, Washakie, Medicine Bow, Fort Fetterman, eight miles southeast of Green River Station.	Barrell's Springs, Green River Station above fish-beds, Sage Creek.	Florissant, Castello's Ranch, Elko, mouth of White River.	Cretaceous.	America—Mississippi, Vancouver.	Europe—Sézanne, Mount Bolca, etc.	American Miocene—Alaska, Fort Union; European Miocene.	Present flora.
	CONIFERÆ.										
	Cupressineæ.										
47	Widdringtonia ? complanata, Lx	P. of R							Rel. ?		
48	Taxodium distichum miocenicum, H		E	F. F., C		E				Id	
49	Glyptostrobus Europæus, H					C., F				Id	
	Abietineæ.										
50	Sequoia affinis, Lx					C., E				Rel. !	
51	Sequoia Langsdorfii, Brgt	Haley's Coal				Fl				Id	
52	Sequoia angustifolia, Lx					E				Rel.!	
53	Sequoia (cone of)					C					
54	Sequoia Heeri, Lx				S					Rel	
55	Sequoia brevifolia, H	P. of R								Id. !	
56	Sequoia longifolia, Lx	Haley's, P. of R					Rel				
57	Sequoia acuminata, Lx	B. B					Rel				
58	Sequoia biformis, Lx	P. of R					Rel				
59	Abietites dubius, Lx	R., F. E					Rel				
60	Abietites setiger, Lx	F. E					Rel.!				
61	Pinus palæostrobus?, Ett					C., Fl				Id.?	
	Taxineæ.										
62	Salisburia polymorpha, Lx	F. E						Id. V			

	MONOCOTYLEDONES.									
	GLUMACEÆ.									
	Gramineæ.									
63	Arundo Goepperti?, Mü				G. R				Id.?	
64	Arundo reperta, Lx				G. R				Rel	
65	Arundo? obtusa, Lx	G							Rel.?	
66	Phragmites Œningensis, A. Br	G., B. B., C. C., R			G. R				Id	
67	Phragmites Alaskana, H	Sp. C			G. R				Id	
	Cyperaceæ.									
68	Cyperus Chavanensis, H		E		G. R				Id	
69	Carex Berthoudi, Lx	G							Rel	
	CORONARIÆ.									
	Smilaceæ.									
70	Smilax grandifolia, Ung	C. C., Gehrung's		C					Id	
	SCITAMINEÆ.									
	Zingiberaceæ.									
71	Zingiberites dubius, Lx	G							Rel. ?	
	Musaceæ.									
72	Musophyllum complicatum, Lx			8 miles SE				E. Rel. !	Rel	
	ENSATÆ.									
	Hydrocharideæ.									
73	Ottelia Americana, Lx	P. of R						E. Rel. !		Rel.
	POTAMEÆ.									
	Najadeæ.									
74	Caulinites sparganioides, Lx	B. B., G., Sp. C							Rel	
75	Caulinites fecundus, Lx	E								
	FLUVIALES.									
	Lemnaceæ.									
76	Lemna scutata, Dr	P. of R								
	SPADICIFLORÆ.									
	Araceæ.									
77	Pistia corrugata, Lx	P. of R								Rel.

Table of distribution of the species of the Tertiary flora—Continued.

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	Aroideæ.										
78	Acorus brachystachys, H	B. B.		C., W		C				Id	
	Incertæ sedis.										
79	Eriocolon ? porosum, Lx	S. C									
80	Phyllites improbatus, Lx	B. B									
	PRINCIPES.										
	Palmæ.										
81	Flabellaria Zinkeni ?, H	G			B. S. ?					Id	
82	Flabellaria Eocenica, Lx	G							E. Id. ?		
83	Sabalites Grayanus, Lx	G., P. of R						M., V			
84	Sabalites Campbellii, N	R., G., B. B., etc							E. Rel	F. U. !	
85	Sabalites fructifer, Lx	G									
86	Geonomites Goldianus, Lx	G							Séz. Rel		
87	Geonomites Schimperi, Lx	Y. S. Lake							E. Rel		
88	Geonomites tenuirachis, Lx	R					Rel. !				
89	Geonomites Ungeri, Lx	R							E. Rel		
90	Palmocarpon compositum, Lx	Pl.									
91	Palmocarpon Mexicanum, Lx	Pl.									
92	Palmocarpon commune, Lx	R., G., B. B									
93	Palmocarpon truncatum, Lx	G									
94	Palmocarpon corrugatum, Lx	G									
95	Palmocarpon subcylindricum, Lx	G									

	DICOTYLEDONES.										
	APETALÆ.										
	AMENTACEÆ.										
	Myricaceæ.										
96	Myrica Torreyi, Lx	B. B							E. Rel	Rel.	
97	Myrica acuminata, U					Fl., W. R				Id.	
98	Myrica Copeana, Lx					Fl.				Rel.	
99	Myrica undulata, H					E.				Id.	
100	Myrica nigricans, Lx				G. R.						Rel.
101	Myrica Bolanderi, Lx					E.					
102	Myrica Ludwigii, Schp					W. R				Id.	
103	Myrica latiloba, H					Fl.				Id.	
104	Myrica partita, Lx					E.				Rel	
105	Myrica Brongniarti ?, Ett					E.				Id. ?	
106	Myrica insignis, Lx					Fl.					
107	Myrica ? Lessigii, Lx	Coal Creek								Rel.	
	Betulaceæ.										
108	Betula Vogdesii, Lx			F. F.						Rel !	
109	Betula gracilis ?, Ludw	G								Id. ?	
110	Betula Goepperti, Lx		E.							Rel. !	
111	Betula Stevensoni, Lx		E.	C.							
112	Alnus Kefersteinii, G		E.	8 miles SE.		Fl.				Id.	
113	Alnites inæquilateralis, Lx	A. Station							E. Séz		
	Cupuliferæ.										
114	Carpinus grandis, U					Fl., E				Id.	
115	Corylus Macquarrii, (F.) H			C., W.						E., Al., Id.	
116	Fagus Feroniæ, U					E.				Id.	
117	Quercus neriifolia, A. Br	R.				Fl.				Id.	
118	Quercus straminea, Lx	G								Rel. ?	
119	Quercus chlorophylla, U	M., E., R., F. E.								Id.	
120	Quercus cinereoides, Lx	(?)									Rel.
121	Quercus Valdensis, H			R. C., W.						Id.	
122	Quercus ? Godeti, H	Sp. C								Id.	
123	Quercus Cleburni, Lx	B. B.								Rel.	
124	Quercus ? fraxinifolia, Lx	Sp. C								Rel.	
125	Quercus Ellisiana, Lx	Sp. C								Rel.	
126	Quercus Pealei, Lx	Sp. C								Rel.	
127	Quercus Haidingeri, Ett				G. R.					Id	
128	Quercus drymeja, U					C.				Id.	

Table of distribution of the species of the Tertiary flora—Continued.

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129	Quercus Haydenii, Lx			R. C							
130	Quercus acrodon, Lx			R. C							Rel.?
131	Quercus Viburnifolia, Lx	S. C., G., B. B								Rel. ?	
132	Quercus platania, H			C						Id	
133	Quercus negundoides, Lx		E								
134	Quercus angustiloba, A. Br	G								Id	
135	Dryophyllum crenatum, Lx	P. of R					Rel				
136	Dryophyllum subfalcatum, Lx	P. of R							E. Rel. !		
137	Castanea intermedia, Lx					Fl				Rel. !	Rel.
	Salicineæ.										
138	Salix integra, G	B. B., G								Id	
139	Salix media, H				G. R	E				Id	
140	Salix angusta, A. Br	Sp. C			G. R					Id	
141	Salix elongata, O. W					E				Id	
142	Populus latior-cordifolia, H			W						Id	
143	Populus subrotundata, Lx		E	R. C., C						Rel. !	
144	Populus melanaria, H	P. of R								Id	
145	Populus melanarioides, Lx	P. of R								Rel. !	
146	Populus Ungeri, Lx	G								Rel	
147	Populus lævigata, Lx			R. C						Rel. !	
148	Populus Zaddachi, H				G. R					Id. !	
149	Populus Richardsoni, H					E				Id. !	
150	Populus mutabilis, H	Sp. C., B. B	E							Id	

151	Populus arctica, H		T. C	C	G. R					Id.!	
152	Populus decipiens, Lx			C., W						Rel.!	
153	Populus monodon, Lx	R						M. Id.			
	Plataneæ.										
154	Platanus Guillelmæ, G			C., W						Id	
155	Platanus aceroides, G			C., W						Id	
156	Platanus Raynoldsii, Ny	G								F. U. Id.	
157	Platanus rhomboidea, Lx	G								F.U.Rel.!	
158	Platanus Haydenii, Ny*	G., B. B								F. U. Id.!	
	URTICINEÆ.										
	Ulmaceæ.										
159	Ulmus tenuinervis, Lx					Fl., C				Rel.!	
160	Planera longifolia, Lx					E., C., W. R.				Rel.!	
161	Planera Ungeri, Ett					E				Id.!	
	Moreæ.										
162	Ficus lanceolata, H				G. R	Fl				Id	
163	Ficus Jynx, U					E				Id	
164	Ficus multinervis, H				G. R					Id	
165	Ficus oblanceolata, Lx			C							
166	Ficus arenacea, Lx				G. R					Rel	
167	Ficus Ungeri, Lx				G. R						Rel.
168	Ficus irregularis, Lx	G							Séz. Rel		
169	Ficus uncata, Lx	R., Coal Creek		C					Séz. Rel		
170	Ficus Haydenii, Lx	B. B								Rel.?	
171	Ficus ovalis, Lx	Pleasant Park									
172	Ficus Dalmatica, Ett	P. of R								Id	
173	Ficus spectabilis, Lx	G									
174	Ficus Smithsoniana, Lx	R								Rel.?	
175	Ficus occidentalis, Lx	G									
176	Ficus planicostata, Lx	B. B., G., P. of R., Coal C									
177	Ficus planicostata var. latifolia, Lx	B. B., G									
178	Ficus planicostata var. Goldiana, Lx	G							Séz. Rel.		
179	Ficus tiliæfolia, A. Br	P. of R., Sp. C., S. C., B. B	E	W						Id	
180	Ficus pseudo-populus, Lx		E		G. R			M Re'			
181	Ficus Wyomingiana, Lx				G. R						
182	Ficus subtruncata, Lx	G								Rel.!	

Platanus Haydenii, Newby., is one of the most common species of Golden, found also at Black Buttes, but more rarely. We have a splendid specimen from Rev. A. Lakes, representing upon the same block of sandstone the two leaves figured by the author (pl. xix and xxi).

Table of distribution of the species of the Tertiary flora—Continued.

	Names of species.	First Group. Raton Mountains, Placière, Cañon City, Golden, Marshall's, Erie, Sand Creek, Henry's Fork, Fort Ellis and Spring Cañon, Black Buttes, Alkali Station, Point of Rocks, Yellowstone Lake.	Second Group. Evanston, Mount Brosse, Troublesome Creek, Bridger's Pass.	Third Group. Carbon, Rock Creek, Washakie, Medicine Bow, Fort Fetterman, eight miles southeast of Green River Station.	Fourth Group. Lower Green River. Barrell's Springs, Green River Station above fish-beds, Sage Creek.	Fourth Group. Upper Green River. Florissant, Castello's Ranch, Elko, mouth of White River.	Cretaceous.	Eocene. America—Mississippi, Vancouver.	Eocene. Europe—Sézanne, Mount Bolca, etc.	American Miocene—Alaska, Fort Union; European Miocene.	Present flora.
183	Ficus auriculata, Lx	Sp. C., G., Coal Creek									
184	Ficus asarifolia, Ett	G., P. of R., R								Id	
	OLERACEÆ.										
	Polygoneæ.										
185	Coccoloba lævigata, Lx			C							Rel.
	Nyctagineæ.										
186	Pisonia racemosa, Lx	B. B								Rel	
	PROTEINEÆ.										
	Proteæ.										
187	Lomatia? microphylla, Lx			8 miles SE						Rel.!	
	LAURINEÆ.										
	Lauraceæ.										
188	Laurus socialis, Lx		E							Rel.!	
189	Laurus primigenia, U		E							Id	
190	Laurus ocoteoides, Lx	G									Rel.
191	Laurus præstans, Lx	P. of R						M.Rel		Rel	
192	Laurus Utahensis, Lx		B. P								Rel.
193	Laurus Brossiana, Lx		Mt. Br								Rel.
194	Tetranthera sessiliflora, Lx		E								Rel.
195	Cinnamomum lanceolatum, U		E							Id	

196	Cinnamomum affine, Lx	G., B. B., M		C				Mis. Id. !		Rel. !	
197	Cinnamomum Scheuchzeri, H	Sp. C								Id	
198	Cinnamomum polymorphum, A. Br	G								Id	
199	Daphnogene Anglica ?, H	G							E. Id. ?		
	GAMOPETALÆ.										
	Lonicereæ.										
200	Viburnum marginatum, Lx	B. B., P. of R., G							Séz. Rel.!		
201	Viburnum platanoides, Lx	B. B.							Séz. Rel		
202	Viburnum rotundifolium, Lx	B. B., P. of R							Séz. Rel		
203	Viburnum dichotomum, Lx	B. B.							Séz. Rel		
204	Viburnum Whymperi ?, H	B. B., P. of R								Id. ?	
205	Viburnum Lakesii, Lx	G									
206	Viburnum anceps, Lx	G									
207	Viburnum Goldianum, Lx	G									
208	Viburnum solitarium, Lx	G									
	ASCLEPIADINEÆ.										
	Oleaceæ.										
209	Fraxinus denticulata, H	Sp. C	E							Id.	
210	Fraxinus prædicta, H					C				Id.	
211	Fraxinus Eocenica, Lx	G									Rel.
212	Fraxinus Brownellii, Lx					C				Rel.	
	DIOSPYRINEÆ.										
	Ebenaceæ.										
213	Diospyros ? ficoidea, Lx	B. B.								Rel. ?	
214	Diospyros brachysepala, A. Br	G., B. B., P. of R								Id.	
215	Diospyros Copeana, Lx					E				Rel.	
216	Diospyros Wodani, U		E							Id.	
	ERICINEÆ.										
	Ericaceæ.										
217	Andromeda Grayana, H	Sp. C								Id.	
218	Vaccinium reticulatum ?, A. Br					Fl.				Id. ?	
	POLYPETALÆ.										
	UMBELLIFLORÆ.										
	Araliaceæ.										
219	Aralia? gracilis, Lx		B. P				Rel			Rel.	

Table of distribution of the species of the Tertiary flora—Continued.

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220	Aralia notata, Lx		Mt. Br., E., Elk Creek							F. U. Id.	
	Ampelideæ.										
221	Cissus lævigata, Lx	G									
222	Cissus Parrotiæfolia			M. B.	G. R.						
223	Cissus lobato-crenata, Lx	B. B	Mt. Br.						Séz. Rel.	F. U. Id.	
224	Cissus tricuspidata, H	B. B.								F. U., E. Id.	
225	Vitis Olriki, H	R.	E.							Id.	
226	Vitis sparsa, Lx	B. B.								Rel.	
227	Ampelopsis tertiaria, Lx				G. R.						Rel. !
	Corneæ.										
228	Cornus suborbifera, Lx	G.								Rel. !	
229	Cornus impressa, Lx		Mt. Br.							Rel	
230	Cornus Studeri ?, H	G	E.							Id. !	
231	Cornus rhamnifolia, O. W			W.						Id.	
	Nysseæ.										
232	Nyssa lanceolata, Lx	G., Sp. C.									Rel.
	CORNICULACEÆ.										
	Saxifrageæ.										
233	Callicoma microphylla, Ett.					Fl., C., E.				Id.	

	POLYCARPICÆ.										
	Magnoliaceæ.										
234	Magnolia Lesleyana, Lx	R., G						M Id			
235	Magnolia tenuinervis, Lx	G., B. B								Rel.	
236	Magnolia Hilgardiana, Lx	R						M .Id			
237	Magnolia attenuata, O. W.	R								Id. ?	
	Annonaceæ.										
238	Asimina Eocenica, Lx			C.						Rel.	Rel.
	NYMPHEINEÆ.										
	Nelumbonæ.										
239	Nelumbium Lakesii, Lx	G								Rel. ?	
240	Nelumbium tenuifolium, Lx	S. C								Rel. ?	
	MALVOIDEÆ.										
	Büttneriaceæ.										
241	Dombeyopsis platanoides, Lx	Sp. C								Rel.	
242	Dombeyopsis trivials, Lx	G									
243	Dombeyopsis obtusa, Lx	G									
244	Dombeyopsis grandifolia, U	G								Id.	
	Tiliaceæ.										
245	Grewiopsis Saportana, Lx	B. B							Séz. Rel.!		
246	Grewiopsis tenuifolia, Lx	B. B							Séz. Rel.!		
247	Grewiopsis Cleburni, Lx	P. of R							Séz. Rel.!		
248	Apeibopsis discolor, Lx	B. B								Rel. !	
	ACERINEÆ.										
	Aceraceæ.										
249	Acer trilobatum var. productum, A. Br			C						Id.	
250	Acer æquidentatum, Lx					W. R.					Cal. Plioc.
	Sapindaceæ.										
251	Sapindus caudatus, Lx	G., B. B								Rel.	
252	Sapindus Stellariæfolius, Lx					Fl., C.				Rel.	
253	Sapindus angustifolius, Lx					Fl., C.				Rel.	
254	Sapindus coriaceus, Lx					E.				Rel.	
255	Sapindus Dentoni, Lx					W. R.					
256	Sapindus obtusifolius, Lx			8 miles SE						F.U.,Rel.	

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	FRANGULACEÆ.										
	Staphylaceæ.										
257	Staphylea acuminata, Lx					Fl., C.					Rel. !
	Celastreæ.										
258	Celastrinites artocarpioides, Lx	G							Sez., Rel		
259	Celastrinites lævigatus, Lx	Sp. C.							Sez., Rel.		
	Iliceæ.										
260	Ilex Wyomingiana, Lx				G. R.						Rel. ?
261	Ilex affinis, Lx				G. R.					Rel.	
262	Ilex subdenticulata, Lx					Fl.				Rel. !	
263	Ilex dissimilis, Lx				S. C.					Rel	
	Rhamneæ.										
264	Paliurus Colombi, H			W., C.						Id	
265	Paliurus Florissanti, Lx					Fl					Rel.
266	Paliurus zizyphoides, Lx	G., B. B									
267	Zizyphus distortus, Lx	G									
268	Zizyphus Meekii, Lx			C						Rel. !	
269	Zizyphus hyperboreus ?, H			C						Id. ?	
270	Zizyphus fibrillosus, Lx	G., B. B									
271	Zizyphus cinnamomoides, Lx				G. R					Rel	
272	Berchemia multinervis, A. Br	R								Id.	

273	Rhamnus alaternoides, H	G								Id.	
274	Rhamnus rectinervis, H	G., B. B., C., R.	E							Id.	
275	Rhamnus inæqualis, Lx	G								Rel.	
276	Rhamnus discolor, Lx	B. B								Rel. ?	
277	Rhamnus Cleburni, Lx	G., B. B							Séz. Rel		
278	Rhamnus Goldianus, Lx	G., B. B		C					Séz. Rel		
279	Rhamnus obovatus, Lx	R., G									
280	Rhamnus intermedius, Lx		B. P					M. Rel			Rel.
281	Rhamnus salicifolius	B. B., M								Id	
282	Rhamnus Rossmässleri, O. W	B. B									
	TEREBINTHINEÆ.										
	Juglandeæ										
283	Juglans rhamnoides, Lx	S. C., B. B., P. of R								F. U Rel. !	
284	Juglans Leconteana, Lx	M. !	E							F. U. Rel.	
285	Juglans rugosa, Lx	S. C., B. B., G	E							F. U. Eur. Rel. !	
286	Juglans thermalis, Lx	G				Fl., Hot Spr				Rel	
287	Juglans Schimperi, Lx	G			G. R						
288	Juglans alkalina, Lx	A. St							Séz. Rel		
289	Juglans denticulata, H			C	G. R					Id	
290	Carya antiquorum, Ny		E							F. U. Id.	
291	Pterocarya Americana, Lx					Fl				Rel	
	Anacardiaceæ.										
292	Rhus Evansii, Lx		E			Fl				Rel	
293	Rhus membranacea, Lx	P. of R								Rel. !	
294	Rhus pseudo-Meriani, Lx	B. B								Rel	
295	Rhus rosæfolia, Lx					Fl					
296	Rhus Haydenii, Lx					Fl				Rel	
	Zanthoxyleæ.										
297	Zanthoxylum juglandinum, A. Br			W						Id	
	CALYCIFLORÆ										
	Halorageæ.										
298	Trapa ? microphylla, Lx	P. of R									
	MYRTIFLORÆ.										
	Myrtaceæ.										
299	Eucalyptus Hæringiana ?, Ett	B. B								Id. ?	
300	Eucalyptus Americana, Lx				G. R					Rel	

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	ROSIFLORÆ.										
	Pomaceæ.										
301	Cratægus æquidentata, Lx			C						Rel	
	LEGUMINOSÆ.										
302	Podogonium Americanum, Lx	B. B								Rel	
303	Cassia concinna ?, H		E							Id, ?	
304	Acacia septentrionalis, Lx					C				Rel	
305	Mimosites linearifolius, Lx					Fl				Rel	
306	Leguminosites cassioides, Lx	S. C			G. R					Rel	
307	Leguminosites arachioides, Lx		E								
	Incertæ sedis.										
308	Phyllites sapindiformis, Lx				G. R						
309	Carpites lineatus, Ny		E							F. U. Id	
310	Carpites oviformis, Lx	G								Rel	
311	Carpites triangulosus, Lx	G., P. of R									
312	Carpites costatus, Lx	G									
313	Carpites coffeæformis, Lx	G									
314	Carpites myricarum, Lx	B. B								Rel	
315	Carpites rostellatus, Lx	G									
316	Carpites glumæformis, Lx	B. B									
317	Carpites mitratus, Lx	B. B									
318	Carpites laurineus, Lx		E								Rel.

319	Carpites Utahensis, Lx		E								
320	Carpites verrucosus, Lx	B. B									
321	Carpites minutulus, Lx	G									
322	Carpites Viburni, Lx	B. B								Rel	
323	Carpites spiralis, Lx	P									
324	Carpites rhomboidalis, Lx	G									
325	Carpites bursæformis, Lx	B. B									
326	Carpites Pealei, Lx					Fl					
327	Carpites cocculoides, H., et var. major			C., W						Id	
328	Carpites ligatus, Lx	P									
329	Carpites valvatus, Lx	Fort Steele								Rel	

The whole number of species in this table is three hundred and twenty-nine, two hundred of which are credited to the Lower Lignitic.

This superiority of the representatives of the flora of the lower group is due, first to the wide extent in surface and to the thickness of this division and of its seams of lignite, which are already widely worked, thus exposing at many localities beds of shale abounding in vegetable remains; then to more careful researches pursued in this division of the Tertiary than in any other. These careful researches have brought on the discovery of fruits and seeds at Golden and Black Buttes. Of these two hundred species, fifty-seven are credited to Golden only, thirty-one to Black Buttes, and seventeen to Point of Rocks.

Considering first the relation between the Bitter Creek series or the Lower Lignitic of Wyoming with that of Colorado, we find Black Buttes and Golden with nineteen species in common, four of which have been found also at the Raton Mountains, and four at other localities of the Lower Lignitic of Colorado, and besides, out of the species of Point of Rocks, Golden has eight, three of them seen also at other named localities of the Colorado Basin, or in all we count twenty-six species found in both the Colorado and the Wyoming Lower Lignitic. These and the peculiar types represented by the species are sufficient to indicate the synchronism of the formations.

The different localities referred to the Lower Lignitic group in the Colorado Basin have their relation recorded by ten of the Raton Mountains, seven of which are at Golden only, and three more at Golden and Marshall's. Besides these, Golden has three of its species at Marshall's, four at Sand Creek, one identified with Cañon City, which has one of its species also at Sand Creek. Erie has one species of the Raton Mountains. As seen from the table, Sand Creek, and especially Marshall's, Cañon City, and Erie, are as yet represented by very few species, and, therefore, the relation between the localities is comparatively and proportionally quite as evident as it is between Black Buttes and Golden

The number of the species of the lower group represented in the upper divisions is remarkably small. We count *Halimenites major*, abundant in all the localities of the Lower Lignitic. It has been found in the Cretaceous underneath, and ascends in the Tertiary as high as Carbon. *Sequoia Langsdorffii*, most common in the European Miocene, very rare at Black Buttes,

is abundant at Florissant, fourth group. *Phragmites* should perhaps be, as a genus, eliminated from the number of local representatives on account of the uncertainty of the determination of the fragments; for, according to what has been remarked in the description of the specimens referred to *P. Œningensis*, they may be referable to divers generic types. Hence the distribution of these fragments in most of the groups cannot be depended upon as evidence of relation of age. The same might be said of *Acorus branchystachys*, found at Black Buttes in poor specimens, their identification with those of Carbon and Florissant being doubtful. Then we have *Flabellaria Zinkeni* in common at Golden and Barrell's Springs. From the remark added to the description of the species, it is seen that the relation of the fragments from Barrell's Springs is not ascertained, no more than the reference of the locality to the third group. Then we have *Populus mutabilis*, which prevails in two localities of the lower group, and is also found at Evanston; *Ficus uncata*, described from specimens of the Raton Mountains, Golden, and Carbon, or from the first and third groups; *Ficus tiliæfolia*, an omnipresent species, most common in the European Miocene, and with us seen at nearly all the localities of the Lower Lignitic, and also at Evanston in the Washakie group, and even in the Pliocene of California. *Cinnamomum affine* also, which, common in the Lower Lignitic, has been found at Carbon; *Cissus parrotiæfolia*, a rare species, seen at Marshall's, Mount Brosse, and the Lower Green River group; *Cissus lobato-crenata*, found at Black Buttes and Mount Brosse; *Rhamnus rectinervis*, common in the Miocene of Europe, as also in the Lower American Lignitic, seen at Evanston; and then *Juglans Leconteana* and *J. rugosa*, two species which relate to or perhaps represent the most common *J. acuminata* of the European Miocene, and which, rarely found at Evanston, abound in different localities of the first groups. Quoting still a small fruit, *Carpites glumaceus*, obtained from Black Buttes and Evanston, we have, as indicated in the table of these two hundred species of the Lower Lignitic, sixteen only which pass into, or have been recognized in higher groups of the Tertiary. This shows a unity and isolation of the Lower Lignitic the more remarkable that none of its essential types, the Palms, Magnolias, *Grewiopsis*, *Viburnum*, *Rhamnus*, etc., have, at least from what is known now, passed above it.

The second group, that of Evanston, has a peculiar flora, and thus an indefinite relation, either in regard to the other divisions, or to the different

localities ascribed to it. It is, moreover, insufficiently known; for it is represented until now by only thirty-four species, twenty of which are limited in their range to this division. Of the other, *Taxodium distichum miocenicum* is at Fort Fetterman and Elko. *Populus arctica*, of the Miocene Arctic flora, abundant at Carbon, found at Green River, is also of frequent occurrence in the Miocene of Alaska. With the third group, that of Evanston has still in common *Betula Stevensoni*, *Alnus Kefersteinii*, *Populus subrotundata*, and *Ficus tiliæfolia*, all species, like the former ones, of Miocene type, as well as *Rhus Evansii*, which it has in common with the Upper Green River group. With the lower group, its relation is merely by *Populus mutabilis*, *Ficus tiliæfolia*, *Cissus lobato-crenata*, *Rhamnus rectinervis?*, *Juglans rugosa*, and *J. Leconteana*, already remarked upon, with four species of *Carpites* or fruits, whose relation of age is too indefinite to be taken into account. The amount of affinity with the first group is, therefore, by the count of species, about the same as with the upper divisions; but those relating it to the lower one are, like the other forms, of Miocene type, even *Cissus lobato-crenata*, whose affinity is with a species of the Union group, and with *C. tricuspidata* of Alaska. Hence the correlation of age, as far as it can be recognized, is with the upper group, mostly with the Miocene.

The vegetable types peculiar to this second division are especially *Laurineæ*, represented by five species, while the whole Tertiary flora of the Lignitic has until now only seven, the two others pertaining to the lower group. These five species have a distinct affinity with European Lower Miocene types, as well as *Betula Gœpperti*, *Cornus impressa*, *Cassia concinna*, while *Cinnamomum lanceolatum*, *Diospyros Wodani*, *Vitis Olriki*, *Cornus Studeri*, are true European Miocene species. Hence the relation of the group tends upward. Its *Aralia gracilis* and *A. notata* have the same degree of relation to Cretaceous types of Nebraska as to Pliocene species of California, and *Quercus negundoides*, *Rhamnus intermedius*, and *Carya antiquorum* have no distinctly marked relation to other fossil plants described until now. Therefore, the general character of the plants is Miocene, scarcely modified by a few forms passing to the lower divisions. I find, however, no sufficient reason to unite it to Carbon, from which some of its essential types differ, and it cannot be certainly united to the lower group of the Tertiary, of which it has not one of the essential Eocene characteristic species. This small flora seems to represent a peculiar stage intermediate between

the first and the third division. The same may be said of the climatic circumstances evidenced by the plants.

The third group, that of Carbon, has, by its thirty-seven species, an evident Middle Miocene facies indicated by the relation of its plants to the Miocene flora of Alaska, Greenland, Spitzbergen, and of Europe also. It is clearly defined in the few localities which are referred to it, either considered in its proper plants, or separately from its affinities with the floras of the other groups. It has, at Carbon, seven species; found also at Washakie: *Acorus branchystachys* of the Spitzbergen flora; *Corylus MacQuarrii* of Alaska and Greenland; *Populus decipiens*, same type as *Paliurus Colombi* of the Miocene of Alaska; *Platanus aceroides*, *P. Guillelmæ*, both common in the Middle and the Upper Miocene of Europe (Oeningen), and also of Greenland and Spitzbergen, with *Paliurus Colombi* and *Carpites cocculoides.* Of the two species of Fort Fetterman, Carbon has *Taxodium distichum miocenicum*, whose relation of age is indicated by its name, and, with Rock Creek, *Populus subrotundata*, closely allied to *P. attenuata* of Oeningen. This *Populus* is also in the Union group. Of species discovered at one locality only, we have at Carbon, *Quercus platania*, described by Heer, from specimens of Greenland and Spitzbergen; *Zizyphus Meekii* and *Z. hyperboreus*, two species closely allied, even perhaps identical, the last of which is in the Greenland Miocene; *Asimina Eocenica*, comparable to the living *A. triloba;* and two others, whose affinity is not yet clearly recognized, *Ficus obovata* and *Coccoloba lævigata*, this last one, however, compared to a species of the present flora. Rock Creek has for itself *Quercus Valdensis*, a Miocene species of Europe, *Q. Haydenii*, *Q. acrodon*, and *Populus lævigata*, representing Miocene type, though not identified with any other species. From Washakie, we have *Populus latior*, a most common and variable species of the Upper Miocene of Europe, especially of the Oeningen flora, found also at Alaska; and from Fort Fetterman *Betula Vogdesii*, a Miocene type. Four species more are ascribed to this group from an isolated locality eight miles southeast of Green River Station, considered by its geological station as referable to the Washakie group. They are *Musophyllum complicatum*, *Lomatia? microphylla*, *Sapindus obtusifolius*, and *Alnus Kefersteinii*. This last is common in the Upper Miocene of Europe, and has been also described from Alaska, Greenland, and Iceland. *Sapindus obtusifolius* has its affinity with a species of the Union group, *S. membranaceus;* the two others are allied to

European Miocene types. The Miocene facies of the Carbon group is not contradicted by the few species which it has in common with those of the other divisions of the Lignitic Tertiary; for to the first group it is allied only by *Halimenites major*, a marine plant whose wide distribution has been remarked, *Ficus tiliæfolia*, *Cinnamomum affine*, whose relation is with Miocene plants of Europe, and *Ficus uncata*, of unknown affinity. No Eocene type is seen in this third group. It has, in common with the Evanston or second group, *Populus arctica* of the Miocene of Greenland, besides *Ficus tiliæfolia*, *Populus subrotundata*, *Alnus Kefersteinii*, species already named as Miocene. The only species of unknown affinity described from the second and the third group is *Betula Stevensoni*.

With the fourth group, the relation presents the same degree of analogy by Miocene types: *Populus arctica*, *Alnus Kefersteinii*, *Acorus branchystachys*, already considered; *Juglans denticulata* of the Baltic and Greenland Miocene; *Acer trilobatum*, a predominant species of the Miocene of Europe, which has not yet been recognized in the Arctic regions; *Equisetum Haydenii* and *Cissus Parrotiæfolia*, Miocene types also, the last, however, not positively identified with any species of that epoch. Hence we have, in this Carbon group, not only the relation of age indicated by most of the plants described from it, but also that of climate, proved by the affinity of the largest number of its species with those of Greenland, Spitzbergen, and Alaska. The plants evidence a climate like that of the middle zone of the United States at our epoch; as from Ohio to North Alabama.

I have separated the Green River or fourth group in two parts on account of the indefinite relation of the species of each of them, and therefore of the peculiar facies of their flora. I am, moreover, uncertain in regard to the exact locality of a number of specimens, which were sent without labels, and which I refer to the Lower Green River group by mere affinity of types, specimens which represent especially *Ficus arenacea* in its various forms, and *Cinnamomum affine*.

The position of the Green River group as fixed by stratigraphy is above the Washakie or Lignite productive group. Its compounds are peculiar, mostly deposits of shallow fresh-water lakes, containing a profusion of fish remains, and rich in bitumen, resulting from animal decomposition, rather than from the growth of boggy plants; for until now, to my knowledge, no bed of true Lignitic coal has been discovered in this formation. The

so-called coal of Elko Station is a shaly compound impregnated by bitumen. The flora, which is already somewhat explored, but which promises for the future an abundant harvest of rich and very interesting materials, has a character quite at variance with that of the other groups as seen here below. Taken altogether, it is represented by ninety-three species, of which thirty-four are credited to the lower division and fifty-nine to the upper. The first impression in looking over the table of distribution must excite a doubt about the relation of age of these two subdivisions in considering the great dissimilarity of the characters of their representative plants, for two species only are found common to both, *Ficus lanceolata* and *Salix media*, both European Miocene. This dissimilarity may be accounted for by local distribution, for the lower division is merely represented by one locality, the cut-off near Green River Station, from which Dr. Hayden obtained, when the construction of the railroad was in progress, a number of fine specimens. The two other localities ascribed to the section, Sage Creek and Barrell's Springs, have too few species for points of comparison; and, in regard to their age, *Sequoia Heerii* and *Ilex dissimilis* of Sage Creek, are merely related to Miocene species, while *Lygodium neuropteroides* of Barrell's Springs is of a peculiar type, without affinity to any other of the Tertiary. With this it has only *Equisetum Haydenii*, which relates it to the second group, and *Flabellaria Zinkeni* to the first. Hence we have, at the Green River cut-off, a flora which has to be considered in itself, or which does not offer any distinct affinity with that of the other Tertiary divisions. It is, therefore, on account of the geological distribution of the strata and of their compound, that I refer it to the Green River formations. Some of its types seem to indicate it as more recent than that of Carbon.

With the first or Lower Lignitic group, the flora of the Lower Green River has in common the two *Phragmites*, *P. Œningensis* and *P. Alaskana*, represented by fragments of stems and leaves. The first is of general distribution; the second indicates an affinity with the North Miocene. It has also *Salix angusta*, which is Upper Miocene of Europe, and *Juglans Schimperi*, without distinct affinity. With the second group, it has in common *Populus arctica*, *Ficus pseudo-populus*, and *Juglans denticulata*, also European Miocene types; and with the third, *Populus arctica* and *Cissus Parrotiæfolia*, already remarked upon. In the species which have not been found anywhere else as yet in our American Tertiary measures, we find, as identical to Euro-

pean Miocene species, *Arundo Gœpperti*, *Quercus Haydingeri*, *Populus Zaddachi*, *Ficus multinervis*, and, as related types of the same age peculiar to this group, we have *Equisetum Wyomingense*, *Arundo reperta*, *Ficus arenacea*, and *Eucalyptus Americana*, plants whose affinity seems with more recent vegetable types than those of the Miocene. Two species of *Myrica*, *M. nigricans* and *M. Bolanderi*, are related to congeners of the upper divisions, while *Ilex affinis*, and *Ampelopsis tertiaria*, which is closely related to, even perhaps identical with the living *A. quinquefolia*, relate this group to the present flora. Its affinities are evidently with less ancient types than those of the third group.

But still the Upper Green River division seems to have a more recent character. With the first group, it has in common only *Sequoia Langsdorffii*, *Acorus brachystachys*, and a *Podogonium*, all Upper Miocene. *Juglans thermalis*, found in lava deposits, is of doubtful reference for the station. With the second, it has *Taxodium distichum*, *Acorus brachystachys*, *Alnus Kefersteinii*, and *Acer trilobatum*, all species not merely Miocene, but, as seen from our table, of a very wide and general distribution; and, independently of its relation to the other divisions, the flora of this group has *Glyptostrobus Europeus*, *Pinus palæostrobus*, *Myrica acuminata*, *M. undulata*, *M. Ludwigii*, *M. latiloba*, *Carpinus grandis*, *Fagus feroniæ*, *Quercus drymeja*, *Castanea intermedia*, *Salix elongata*, *Populus Richardsoni*, *Planera Ungeri*, *Ficus Jynx*, *Fraxinus prædicta*, *Vaccinium reticulatum*, all of the European Upper Miocene; and, as closely allied to plants of the same age by their types, two species of *Salvinia*, *Sequoia angustifolia* and *Pterocarya Americana*. The Pliocene flora of California, known now by the species of the Gold-bearing Gravel of Nevada County, and of some other localities, especially of Oregon, offers us also a point of comparison by two identical species, *Ulmus tenuinervis* and *Acer æquidentatum*, while with plants of the present time the relation is marked by *Hypnum Haydenii*, *Equisetum limosum*, and the fine *Staphylea acuminata*. All this evidently weakens in this flora the Miocene facies, so distinct in that of the third group. Indeed, taken altogether, both divisions of the fourth group might be ascribed to the Lower Pliocene; four of their species being, as far as it can be ascertained from the characters of the leaves, identical with plants of our time. The relation to the European Miocene is, however, still too close, while it is too distant from the Pliocene flora represented by the species of the Gold Gravel of California.

In regard to the different localities ascribed to the Upper Green River division, the flora gives positive indication of their synchronism. One of the species most generally found, *Planera longifolia*, is common to all the localities, Castello's Ranch, Florissant, Elko, and mouth of White River. It has been found always in a profusion of specimens. Castello's Ranch and Florissant have besides six species in common; Florissant and mouth of White River, two; Florissant and Elko, two; and Castello's Ranch and Elko, one. The general and peculiar character of the flora is recognized at all the localities; for example, *Salvinia*, *Myrica*, and *Sapindus* are predominant in the whole group, though there may be specific distinctions in the separate habitats. The compounds also, a fine-grained shale, laminated in thin layers of about half a centimeter in thickness, buff-colored or reddish, wherein the remains of plants are preserved, are the same in the four localities from which specimens have been sent. All have, upon their smooth surface, a profusion of broken or crushed remains of Conifers, leaves, fragments of stems, with scales of fishes. This general character is not common to the Lower Green River division. It has remains of fishes, but the matrix preserving specimens is a yellowish sandy shale, coarser than that of the upper group, and more irregularly flaggy.

From the close relation of the flora of the fourth group with that of Carbon, it seems that the climatic circumstances which have governed its vegetation were about the same as those prevailing during the Middle or Upper Miocene period. The preponderance of Conifers; of shrubs, *Myrica*, *Salix*, *Staphylea*, *Paliurus*, *Zizyphus*, *Rhus;* of trees of small size, *Planera*, *Carpinus*, etc., give to the flora a general aspect which recalls that of the vegetation of uplands or valleys of mountains. This facies is not contradicted by the kind of trees recognized from the specimens; for, if *Fagus*, *Castanea*, *Acer*, and *Fraxinus* are represented, there is nearly a total absence of Oaks. The flora does not indicate, however, a lower degree of average temperature than that of Carbon, and the difference in the vegetation seems rather to result from its habitat at a higher altitude. The upheaval of the Rocky Mountains evidently began at the end of the Eocene period. The strata of the Lower Lignitic are tilted up in their whole thickness at the base of the mountains; those of the Upper Green River group, as seen in the Parks at Castello's Ranch, etc., are horizontal, and in no way disturbed in their direction when their ends abut on the primitive rocks. The deposition of their materials,

in lakes whose outlines are in some localities still traceable, has taken place within the area of the upheaved country, or within the range of the mountains. And though, therefore, they represent an epoch far distant from the Eocene, the climatic circumstances may not have been as yet greatly modified; for we find still, in the flora of the fourth group, a few species of *Ficus*, none, however, of the Eocene type; of *Sapindus*, *Acacia*, *Mimosites*, etc., or representatives of genera which, at our time at least, demand for their life an average temperature of a higher degree than it could have been in the uplands, if the atmosphere in the region of the plains had been already cooled. It must be remarked, in regard to this question, that the difference of altitude between the base of the mountains at Golden, Carbon, and the Parks is not very considerable (Golden, 5,600 feet above the sea; Carbon, 6,750; Middle Park, or Florissant, and South Park, at Castello's Ranch, about 8,500); and the supposition also that the flora of the upper fourth group is that of a mountainous region is apparently contradicted by the station of White River, 4,600 feet of altitude only, which has the same flora as the Parks.

I have left, for a conclusion of the remarks upon the age of the flora of the Lignitic, the more important part referring to the general characters of the lower group, a formation which has been and is still considered by some geologists as Cretaceous; for it is advisable to have presented all together the facts and observations which bear on this important subject.

If we separate from the two hundred species ascribed to the first group in the table of distribution those passing up to the other divisions, or those which, either of frequent occurrence or of uncertain determination, cannot be considered as characteristic, and those, too, which, like the *Fungi*, do not afford a reliable point of comparison, we find, in the Lower Lignitic flora, one hundred and thirty species, which may be taken into account as recording, by their characters and their relation, the age of the formation which they represent. Of this number, twenty-seven are identical with Miocene species of Europe, and forty are related to others of the same formation. With the European Eocene flora, nine of the list are identical, and twenty-eight related, while four are related to plants of the present time, five have been described in the Mississippi flora, seven in that of Fort Union, and four from Vancouver. Counting the plants of these three last stations as Tertiary, we have, therefore, the Tertiary facies indicated by one hundred and twenty-four specific forms, while only six represent the Cretaceous. This, it seems,

would be more than sufficient to authorize the conclusion that the flora of the Lower Lignitic is positively Tertiary in its characters. But, as comparisons made from an exposition like that of the table have generally more or less of ambiguity, and can but leave some doubt or distrust on the value of the conclusions, it is advisable to look somewhat deeper into the subject, and to see on what kind and degree of relation is based the assertion that the flora of the Lower Lignitic is of Tertiary age.

The marine plants might perhaps be omitted, as have been the *Lichenes* and the *Fungi*, in a comparison like the one we have to make; for their distribution is too wide and their characters too uncertain. The relation of *Halimenites major*, for example, which is so profusely found in connection with the Lower Lignitic sandstone of Colorado and Wyoming, seems to be quite as distinctly marked with the Cretaceous as with the Tertiary; for Count Saporta has a closely allied form described from the Jurassic, and Prof. Meek has found the identical species at Bear River in strata which he considers positively Cretaceous from the determination of their invertebrate remains. We have, however, to admit a degree of evidence from the predominance of Fucoidal remains in the Lower Lignitic, as equally remarked in the Eocene of Europe, especially of Switzerland. Indeed, it was from the profusion of the so-called Fucoids in the Lower Lignitic sandstone of the Raton Mountains that I received the first indication of the Eocene relation of this formation. The presence of *Delesseria* species in the lower sandstone at Golden was a confirmation of the first impression; for, of the eight species of *Delesseria* described by European authors, seven are Eocene.

Leaving out of count the Fucoids, we have the *Lycopodiaceæ*, a family whose presence is already recorded in the oldest chronicles of the fossil floras of the world, those of the Silurian, and which is especially predominant in the Carboniferous epoch, where its species, mostly large trees, have contributed, with the Ferns and the *Calamariæ*, the essential part of the compounds of the coal. But from the base of the Permian, the *Lycopodiaceæ* seem to disappear completely; for nothing referable to them has been found in the subsequent formations, but two uncertain forms in the Oolite of England, *Lycopodites uncifolius* and *L. falcatus*, Ll. & Hutt., plants whose relation has always been considered as doubtful; as, until now, no species of this order has been described from the Cretaceous and the Tertiary. This disappearance has been a fact the more inexplicable, that the *Lycopodiaceæ* are mostly of hard,

woody texture, and are extremely abundant in the present flora of the whole globe. Therefore its types should, according to the laws of distribution, have been continuous through all the geological epochs. This hypothesis receives a degree of support from the discovery of species of *Selaginella* in the Lower Lignitic of Golden and Point of Rocks, and it affords also a confirmation of the supposed relation of the two plants of the Oolite to this family. Anyhow, the *Lycopodiaceæ* of our Lignitic flora have such a close analogy to species of *Selaginella* living in our time, and are so very different from the *Lycopodites* of the Oolite, that they positively evidence a far more recent origin. Their facies is Tertiary. Recently, according to Count Saporta, fragments of plants similar to those of our *Selaginella laciniata* have been discovered in the Armissan of France.

The Ferns described from the Lower Lignitic measures are all also of Tertiary types. *Sphenopteris Lakesii*, *S. membranacea*, *S. nigricans*, and *Gymnogramma Gardneri* are Eocene according to the same authority, while all the other species represent *Hymenophyllum*, *Pteris*, *Woodwardia*, *Diplazium*, *Lastrea*, *Gymnogramma*, genera positively Tertiary, rather Lower Miocene, and none of these species have as yet any affinity with the Ferns of the Cretaceous. The predominant type of the Ferns in this last formation is that of the *Gleicheniæ*, which appears in the Jurassic, and is in preponderance in all the series of plants described from the Cretaceous of Europe; Belgium, Moletin; of the Arctic, Greenland, etc.; and also of the Dakota group. None of its species have been recognized in the Lignitic. Thus their absence from its flora indirectly contradicts the reference of this formation to the Cretaceous.

The genus *Salvinia*, of which we have three species, is Miocene, at least as far as it is known until now by its five European fossil species.

The more evident relation of the Lower Lignitic flora to that of the Cretaceous is marked in the Conifers, for of this order we have five species, none of which are identical, perhaps, but positively of types preponderant in the Cretaceous flora. Except one, *Abietites dubius*, of uncertain affinity, they all belong to *Sequoia*, a genus appearing in the Cretaceous and becoming predominant in the Tertiary. Its types are extremely persistent, and its species of wide distribution; but, in a fossil state, their specific characters are obscure and difficult to fix. Cretaceous types of Conifers have been found at Point of Rocks, as will be seen below, in connection with more

recent or Miocene ones. Hence, we may consider them here as Cretaceous forms continuing into the Tertiary, like the two species of *Sequoia* of California, which, representatives of the Tertiary, or so closely allied to species of that epoch that their distinction is scarcely possible, have passed, rare and venerable remains of the geological times, to the present flora. *Sequoia Langsdorffii* and *S. brevifolia*, though found in the first group, are two truly Miocene Conifers.

The Palms and the few *Monocotyledones* which are of interest in regard to the evidence of age of the Lower Lignitic are considered hereafter in the remarks on the flora of Point of Rocks.

In the *Dicotyledones*, some generic divisions indicate a geological relation of their species by the exclusive presence of Eocene or Miocene types in the different groups. Thus, in *Myrica*, *M. Torreyi*, an Eocene type, for it is related to species of Mount Bolca, is with *Myrica Lessigii*, a plant of a remarkable character, and as yet of uncertain relation, the only species of the genus found in the Lower Lignitic; while, of ten other species of Miocene affinities, none are found below the fourth group.

In the genus *Populus*, *P. melanaria*, *P. melanarioides*, *P. Ungeri*, and *P. monodon*, all found in localities referred to the first group, are Eocene or lowest Miocene types of Europe. *P. mutabilis* is of wide distribution; and, of six other species of this flora, all Miocene, none are represented in the Lower Lignitic. We have the same difference in regard to the distribution of the species of *Platanus*, for *P. Reynoldsii* and *P. rhomboidea* are of a peculiar type, without any relation with that of the species found in the upper groups; even *P. Haydenii*, with its leaves sometimes without lobes, or merely dentate, may be considered as proper, like the two others, to the American Eocene. The Miocene *Platanus* type, represented by *P. Guillelmæ* and *P. aceroides*, is not found lower than the third group. In *Ficus*, two distinct types are also remarked in the species described in this Flora. The first, that of the lanceolate leaves, appears in the Miocene or upper groups; the other, with broad ovate-lanceolate, generally more or less cordate, palmately nerved leaves, has its species nearly exclusively in the Lower Lignitic. Some of its most abundant representatives, like *F. planicostata*, are recognized in the Eocene of Sézanne as in that of the Mississippi; others, like *F. Dalmatica*, *F. asarifolia*, and others, are either identical or closely allied to species of the lowest Miocene of Europe, Bilin and Monte Promina. The genus *Viburnum* is represented

in this flora only in the Lower Lignitic; none of its species are recognized above, either by fruits or by leaves. In the description, the relation of four species is remarked with the forms published by Saporta in the Sézanne and the Gelinden Flora. The affinity of the species of *Nelumbium* and *Dombeyopsis* is with European forms of the lowest Miocene of Monte Promina, etc. The *Grewiopsis* species, also, all from the Lower Lignitic, have all their affinities to the Eocene of Sézanne. The *Aceraceæ* and the *Sapindaceæ* are especially representatives of the Miocene in Europe; the largest number is found at Œningen; none of them have been recognized in the Eocene. In our Lignitic flora, all the species except *Sapindus caudatus* belong to localities of the third and the fourth group. Per contra, *Rhamnus*, which has in Europe a preponderance of its species in the Lower Tertiary of France, and the Lower Lignitic of Germany and Switzerland, Häring, Monte Promina, Monod, is limited by its American representatives to the Lower Lignitic, first and second groups, for two of them have been found at Evanston. Some of the *Rhamneæ* are considered in the descriptions of *R. Goldianus* and *R. Cleburni* as probably identical to species described from Sézanne under a different generic name.

Of all the localities ascribed to the Lower Lignitic group, that of Point of Rocks is particularly interesting, both by its flora and the position of the strata, where, in 1875, Prof. F. V. Hayden discovered rich deposits of vegetable remains, and collected great numbers of finely preserved specimens, a collection still increased by Mr. Cleburn's researches. This locality is between Black Buttes Station, nine miles northwest of it, and Salt Wells, another station of the Union Pacific Railroad, about the same distance farther west. From Prof. F. B. Meek's report, and from my own, it may be seen that from Black Buttes to Point of Rocks, in following the railroad, the northwestern dip of the measures brings successively in view a series of heavy sandstones interstratified with beds of clay and lignite, whose whole thickness, as remarked already (p. 25) is estimated, according to Messrs. Meek and Bannister, at about four thousand feet. As Point of Rocks Station, where the specimens of Dr. Hayden were found, is only a few miles from the cut end of the ridge, east of Salt Wells, the thickness of the measures is there somewhat less, say about three thousand feet. Though it may be, such a heavy series of strata is passed from Black Buttes to Point of Rocks, that if any part of the so-called Bitter Creek series is Cretaceous, we may expect to find, in the fossil

plants of this last locality, if not a distinct Cretaceous flora, at least a number of representatives of the types of the Dakota group.

The thirty species recognized in the specimens of Point of Rocks have been described above; but the deduction derivable from the determination of these plants in regard to evidence of geological age will be more clearly understood by a comparative table pointing out the affinity or identity of characters with species of other localities. The points of comparison are indicated with the flora of the European and of the Arctic Miocene, of the Canadian Tertiary, of the European Eocene, of Golden, Black Buttes, and the Cretaceous in general.

Table indicating the relation of the fossil plants of Point of Rocks.

[An. signifies analogous; Id., identical.]

	Species of fossil plants described from Point of Rocks.	Canadian Tertiary.	European Miocene.	Arctic Miocene.	European Eocene.	Golden.	Black Buttes.	Cretaceous.
1	Fucus lignitum		An.	An.				
2	Salvinia attenuata		An.					
3	Selaginella laciniata				An.			
4	Selaginella falcata					An.		
5	Sequoia brevifolia		Id.	Id.				
6	Sequoia longifolia						Id.	An.
7	Sequoia biformis							An.
8	Widdringtonia complanata		An.					
9	Pistia corrugata	Id.?						An.
10	Lemna scutata	Id.?						
11	Ottelia Americana							
12	Sabalites Grayanus				An.	Id.		Vancouver.
13	Dryophyllum subfalcatum				An.			
14	Dryophyllum crenatum							An.
15	Populus melanaria		Id.					
16	Populus melanarioides				An.			
17	Ficus asarifolia		Id.					
18	Ficus Dalmatica		Id.					
19	Ficus planicostata				An.	Id.	Id.	
20	Ficus tiliæfolia		Id.			Id.	Id.	
21	Ficus irregularis						Id.	
22	Trapa microphylla	An.						
23	Laurus præstans		An.					
24	Viburnum rotundifolum						Id.	
25	Viburnum Whymperi			Id.			Id.	
26	Viburnum marginatum				An.		Id.	
27	Diospyros brachysepala		Id.			Id.	Id.	
28	Grewiopsis Cleburni				An.		An.	
29	Rhus membranacea		An.					
30	Juglans rhamnoides		An.				Id.	

Of the thirty species enumerated in the table, two appear identical with, and one is related to Canadian species, recognized as Tertiary, as seen below from quotations of Prof. G. M. Dawson's report. Six are identical with, and seven are analogous to, those of the Lower European Miocene; two are identical with, and one allied to, Arctic Miocene species. Seven have a close relation to plants of the Lower European Eocene, Sézanne and Gelinden, two localities composing a subdivision separated at the base of the Tertiary, under the name of Paleocene. Three are identified and one analogous in the flora of Golden; nine identical and one analogous in that of Black Buttes; and four have analogy with Cretaceous forms.

The relation of Point of Rocks with the Canadian Tertiary is especially marked by *Lemna scutata*, a floating plant, described by Prof. J. W. Dawson in the Report of the Geology and Resources of the Region in the Vicinity of the Forty-ninth Parallel. The geologist of the commission, Prof. George Mercer Dawson, obtained the specimens from a bed of clay near the very base of the Lignitic formation, where, according to the information kindly furnished to me the vegetable remains representing the species were very abundant, but difficult to separate in their integrity from the crumbling shale. Though not positively determinable, on account of the indifferent state of preservation of the specimens, this plant has such an analogy of characters with the one described under this name from Point of Rocks, that, being found in the same circumstances of habitat, I consider as positive the identity of both forms. The species is also represented at Point of Rocks by numerous specimens, for one-half of those received from this place bear remains of it, and of another, *Pistia corrugata*, which may be a mere form of the same. The *Trapa* leaves of Point of Rocks are correlated by fruits considered by Prof. Dawson as referable to this genus, and which were found at the same locality as the *Lemna*.

In regard to the identity of the Lignitic measures of Canada with those of the United States, the geological evidence is conclusive. The report quoted above proves it by good sections and diagrams, which expose the same distribution of lignite beds, clay, and sandstone strata, as in the great Lignitic of the Rocky Mountains, of which that of Canada is a mere continuation. It enumerates also, besides those which are described, a number of plants from the Tertiary strata, of a higher stage apparently, for they mostly are of Miocene types.

In remarking upon the first vegetable remains which he had to determine, the celebrated professor of Montreal, J. W. Dawson, says "that the plants of the first group are for the most part identical with those found by American geologists in the Fort Union series, and which have been determined by Prof. Newberry and by Mr. Lesquereux. They are also similar to plants collected by Dr. Richardson in the Lignitic series of the Mackenzie River, as described by Heer, and represented by specimens in the collection of the geological survey, etc. They also approach very closely the so-called Miocene floras of Europe." He then adds,—"If we were to regard the affinities of the plants merely, and to compare them with the Miocene of other countries, and also to consider the fact that several of the species are identical with those still living, and that the whole facies of the flora coincides with that of modern temperate America, little hesitation would be felt in assigning the formation in which they occur to the Miocene period. On the other hand, when we consider the fact that the lower beds of this formation hold the remains of reptiles of Mesozoic types, that the beds pass downward into rocks holding *Baculites* and *Inocerami*, and that a flora essentially similar is found associated with Cretaceous remains both in Dakota and Vancouver Island,* we should be inclined to assign them at least to the base of the Eocene."

From this it seems that Prof. Dawson does not separate the two essential groups of the Tertiary: the upper one with the Miocene types, a flora indicating a temperate climate like that of the middle zone of the United States; the lower one with its numerous species of Palms, of *Ficus*, etc., evidently representing a subtropical vegetation. In this last flora, that of the lower group, now under examination, there is no species identical with or analogous to any of those of the Cretaceous Dakota group. The extraordinary separation of both floras has been sufficiently established by former comparison and description of species. In the upper stage, or Miocene, some rare types of the Cretaceous reappear. Thus apparently the specimens obtained by the survey of Canada mostly represent our third group, or the Upper Lignitic of that country; for Prof. Dawson describes and enumerates from Porcupine Creek seventeen species, all of Miocene type, and most of them formerly described by Prof. Heer and Prof. Newberry from the Miocene

* This assertion may be right for Vancouver, but is not so for the Dakota group. No species of the Dakota group has been found until now at Vancouver whose vegetable types, as far as known, correspond with those of the Lower Lignitic.

formation of Alaska, Greenland, and especially from the Fort Union group, with which the Porcupine Creek group appears closely allied. These plants are:—

Equisetum species, similar to *E. arcticum*, H.
Glyptostrobus Europeus, H.
Sequoia Langsdorffii, Brgt.
Thuya interrupta, Ny.
Phragmites? species.
Scirpus species.
Populus Richardsoni, H.
Corylus rostrata, Ait.
Corylus Americana, Walt.
Diospyros species.
Rhamnus concinnus, Ny.
Carya antiquorum, Ny.
Juglans cinerea? or *J. bilinica*, U.
Viburnum pubescens, Pursh.

To this, and by comparisons, are added the species catalogued by Heer, from Richardson's collection on the Mackenzie, which, says Prof. Dawson, belong to the same region. They are:—

1. *Gyptostrobus Europæus*, H.
2. *Sequoia Langsdorffii*, Brgt.
3. *Pinus* species.
4. *Smilax Franklini*, H.
5. *Populus Richardsoni*, H.
6. *Populus arctica*, H.
7. *Populus Hookeri*, H.
8. *Salix Rheana*, H.
9. *Betula* species.
10. *Corylus MacQuarrii*, H.
11. *Quercus Olafseni*, H.
12. *Platanus aceroides*, G.
13. *Hedera McClurii*, H.
14. *Pterospermites dentatus*, H.
15. *Phyllites aroideus*, H.
16. *Antholithes amissus*, H.
17. *Carpolithes seminulus*, H.

The species described in the same report from the lower stage of the Lignitic of Canada are fewer, and apparently represented by more imperfect specimens. They are:—

Equisetum Parlatorii, H., of the Miocene of Europe, a species to which *E. Haydenii* of Carbon is closely allied. Its habitat is marked as Great Valley.

Lemna scutata, sp. nov., abundant at the Bad Lands, and also at Point of Rocks.

Scirpus species, Bad Lands.

Salix Rheana?, H. (Great Valley), species of the Miocene of Greenland.

Sapindus affinis (Bad Lands), species of the Union group.

Rhamnus, an undescribed species (Great Valley), corresponding to Miocene species of Europe and of the American Lignitic.

Æsculus antiquus, *Trapa borealis*, and a *Carpolithes*, three new species described from obscure specimens from the same locality as that of *Lemna*, the Bad Lands, west of Woody Mountain. These last plants represent a lower geological division, which could not be recognized from the limited number of species pertaining to it. But from the exposition as it is made by Prof. Dawson, it is clear that he had to refer the fossil plants of the Canadian Lignitic to the Tertiary, and consequently the formations also; for, indeed, this flora, as remarked already, has not any vegetable remains which, by comparison, could be recognized as identical or even related to any Cretaceous species.

Coming back to the other plants of Point of Rocks, for considering their characters as an evidence of their age, by comparison with other groups of floras than that of Canada, we find in the table four of them marked as analogous to Cretaceous types. The first, *Pistia corrugata*, has merely a generic relation to *Pistia Mazelii*, Sap. (ined.), lately found in the fresh-water Upper Cretaceous of Fuveau, France. From the sketch kindly communicated by the author, his species is very different in characters from that of Point of Rocks, and therefore it merely evinces the possibility of a relation between the age of the formations. The generic affinity, however, is worth remarking, as it records the first appearance of the genus by two species which represent it, one only on each continent.

By the same degree of affinity, I have marked, in the Cretaceous column of the table, *Sequoia longifolia*, also found at Black Buttes, and *Sequoia*

biformis; the first on account of a distant likeness to *S. Smithiana*, and the other to *S. Reichenbachi* and *S. rigida*, three species recognized, the first in the lower, the two others in both the upper and lower stages of the Cretaceous of Greenland. The wide distribution of *Sequoia* species has been remarked already. But without taking into account the longevity of these types, we have to consider that if we have two Conifers merely related to Cretaceous species, this cannot eliminate the testimony of *Sequoia brevifolia*, which is as profusely represented in the flora of Point of Rocks as *Pistia*, and by specimens in a perfect state of preservation. One-half of the specimens of Mr. Cleburn, besides a large number of those of Prof. Hayden, show it in its two somewhat different forms. As it is distinctly and easily determined, its characters being precise, and as this Conifer is described from the Miocene flora of Greenland and from that of the Baltic, its evidence is more positive than that of the two other species of *Sequoia* represented as yet by small fragments and merely allied to Cretaceous types.

I consider as referable to the Eocene by analogy of distribution *Sabalites Grayanus* and the other species of Palms. The origin of this family in the Cretaceous is indeed an established fact. In one of his last letters, Saporta writes,—"The type of the Palms (*longirachis*) exists in the Upper Cretaceous of Provence. I have received very fine specimens of this type, which seems intermediate between the *Sabal* and the *Phœnix*." Unger and Goeppert have published each one species from the Cretaceous of Germany, and the recent discovery by Schweinfurth of a fruit, *Palmacites rimosus*, Heer, in the Upper Cretaceous White Chalk of the Oasis of Chargeh, west of Thebes (about 25° latitude north), is another evidence of the presence of Palms in the Upper Cretaceous. That, however, remains of this kind are extremely rare, even at the end of the Cretaceous, is proved by the importance attached to the discovery of a fruit of this kind in a region under the tropics. From the Paleocene as represented in the Floras of Gelinden and of Sézanne, no species of Palms have been positively determined; for the fragments described in this last flora under the generic name of *Ludoviopsis* are indefinitely referred by the authors, either to the *Pandaneæ* or to the Palms. The last reference, however, seems right. As yet, of the fifty species of fossil Palms known from their fronds, twenty belong to the Miocene, especially to its lower stage; eight are described from the Tertiary of Italy, without reference to any of its divisions; nine are Oligocene, twelve Eocene, and one

Cretaceous. Of the eight species of *Sabal* described, one species is Miocene, two Oligocene, and five Eocene. *Sabal andegavensis*, Schp., and *S. precursoria*, Schp., two species of the Upper Eocene of France, are very closely related, the first to *Sabalites communis* of Golden, and the other to *Sabalites Grayanus*, found in many localities of the Lower Lignitic from Mississippi to Vancouver. In considering the Lignitic flora by the specimens of fossil plants from Black Buttes, Golden, Colorado Springs, the Raton Mountains, etc., where the preponderance of remains of *Sabal* and *Flabellaria* is so marked, how could it have been possible, if even we had had no other characters for direction, to refer to the Cretaceous the flora of the Lower Lignitic as represented in these localities? The above speaks plainly, and shows how I had to recognize the flora of Vancouver as Tertiary, from the numerous specimens of *Sabal* sent by Prof. Evans, from Nanaimo, even if the other plants of the locality had not been of Tertiary types. It was the same case for the flora of the State of Mississippi, where the Palms are also in preponderance. At Point of Rocks, four large specimens upon sandstone represent the same species of *Sabalites* as that of Vancouver and Mississippi, *S. Grayanus*, which, in the opinion of a celebrated European paleontologist, is one of the finest and most positively characterized species of the genus.

The two species of *Dryophyllum* described from Point of Rocks are indicated in the table of distribution as analogous, one to the Eocene and the other to Cretaceous forms. The genus *Dryophyllum*, as remarked already, has been established for a peculiar section of the Oaks, from species as yet undescribed from the Cretaceous of Belgium. The type which the species represent, like some others of the same formation, does not appear to have reached its full development from or at its origin. We see it, for example, in the Dakota group flora in the proportion of two species in about one hundred and thirty, while in the Paleocene flora of Gelinden, it has four species in thirty, and the same number in forty-eight in the flora of Sézanne. It then reappears more or less frequently in the Tertiary by analogous species of *Quercus*, and may be hence followed through the formations, and nearly without interruption to the present time. From this, it is clear that the reference of fossil species of this genus, when remarked in connection with remains of Tertiary plants, should more appropriately pertain to the Eocene than to the Cretaceous. Therefore, if the presence of species of *Dryophyllum* in the Point of Rocks flora, and that also of *Pistia*, *Sequoia*

biformis, and *Sequoia longifolia*, imparts to it a more ancient physiognomy, it is either as remnants of the past, merely recording a few features of old generations passed away, or as contemporaneous, long-persistent types, which do not distinctly characterize any peculiar epoch. As proof of this assertion, we have the true Lower Eocene character marked in the same flora of Point of Rocks by four species, *Ficus planicostata*, *Viburnum marginatum*, *Populus melanoroides*, and *Grewiopsis Cleburni*, intimately related to species of the Sézanne flora, and not at all or very obscurely to that of the Cretaceous.

The flora of Point of Rocks is allied to that of Black Buttes by nine identical forms, or by one-third of its species. In considering the evidence of synchronism, the identity of two floras could not be more positively proved than this, and, nevertheless, we have here two to three thousand feet of interposed measures. It is a remarkable fact, upon which more will be said presently. The groups of plants at Point of Rocks has, besides the Eocene representatives, six species identified with, and as many related to those of the Miocene of Europe. Therefore, we see here, what has been remarked in other localities of the Lignitic, a compound or admixture of old and young Tertiary types, in comparison at least with the fossil floras of Europe, and thus a general character which does not distinctly relate our first group to any peculiar stage of the European Tertiary. We have the Paleocene by relation to species of Gelinden and Sézanne; the Upper Eocene, especially the Ligurian, or Oligocene, by the Palms; and the Miocene by a number of common and generally distributed forms, which, like *Sequoia brevifolia*, *Sequoia Langsdorfii*, *Populus mutabilis*, *Ficus tiliæfolia*, *Rhamnus rectinervis*, *Juglans rugosa*, etc., are persistent types of wide distribution, indicating merely the Tertiary age for the Lignitic flora. For this reason, I shall continue to carefully record its points of affinity with the divers groups of the geological floras of Europe; but at the same time, denying as yet sufficient evidence for its identification to any of them, I persist in considering it simply as the Lower Eocene flora of this continent.

I said above that the identity of specific forms at Point of Rocks and Black Buttes is worth recording as a remarkable case in regard to the distribution of plants. In marine strata, the persistence of types is a matter of little concern, for the circumstances under which the marine faunas and floras are distributed, for example, the mineral elements entering into the compounds, the depth and temperature of the water, etc., may continue the

same for very long periods. But that a comparatively large number of land or fresh-water plants, subject to modifications or forced to migrations by atmospheric changes, may be preserved identical through the lapse of time indicated by the thickness of the measures heaped along Bitter Creek, has not been proved by as positive an evidence as we have it here. It is scarcely possible to hazard a conjecture upon the length of time indicated by the building-up of these intermediate measures. Evidently of a shore formation, the accumulation of their materials may have been more rapid than for the deposits at the wide bottom of the sea. The strata, however, in their successions, are not merely sandstone beds of great thickness, sometimes blackened by small fragments of land plants ground by the waves, and mixed with other materials, but beds of clay built up of swampy deposits of long duration, and especially lignite or coal-beds, still more clearly denoting the slow progress of the work.

The relation of the floras of Black Buttes and Point of Rocks, in spite of the long periods of time which separate them, as proved by the series of intermediate formations, is, therefore, a fact of great interest to botanists, and not less so to geologists; for it bears upon the perplexed question of synchronism, and at the same time is an important point of comparison in regard to the geographical distribution of our present flora. But here it has to be considered merely in connection with the determination of the age of the Lower Lignitic. The Cretaceous Dakota group is separated from Point of Rocks by a thickness of strata about the same as that which is marked between Point of Rocks and Black Buttes. Nevertheless, between the floras of the Nebraska and Kansas Cretaceous and those of Point of Rocks and Black Buttes, we find few analogous types and not a single identical form. The erosions may have indeed considerably thinned the marine strata representing the Cretaceous above the Dakota group, but that cannot lessen the strength of the deductions made from the total disconnection of the two floras, one of which denotes, by its essential characters, a marked dissimilarity of atmospheric circumstances, a weighty evidence, if not a positive proof, of a change of epoch, not in the sea perhaps, but at least upon the land.

It is useless to repeat that as yet no remains of deep marine Cretaceous types have been discovered in the whole Lignitic measures above Point of Rocks. We may admit, however, that while the Tertiary age was at its beginning represented as a land formation, as seen by its flora, a Cretaceous marine fauna may

have still locally persisted in deep seas. Facts of this kind are recorded in the European geology. The presence of the Saurian *Agathaumas* in the lignite-bed of Black Buttes is then certainly explainable as denoting the wandering of that animal out of its domain, and its death, by penetrating into a peat-bog and being irretrievably swallowed up by its soft matter. If once imbedded in soft peat, no animal, not even man, can get out of it. By this fact, and also by the reason that the coriaceous, ligneous plants of the bogs are not food for mammals, I explain the scarcity of bones of Eocene animals of this kind in the lower beds of the Lignitic. As a shore formation, a surface covered with deep bogs surrounded by sand-wastes, this primitive land would not afford food to mammals, or even be accessible to them. Every one who has explored peat-bogs knows how destitute these formations are of animal life. Few bones of the Aurochs have been found in the bogs of North Germany. They are there quite as rare as human skeletons, and more so than implements of the old races of inhabitants. And the area covered by the American Lignitic shows how compact and continuous, not to say universal, were those swamps of the Lower Tertiary. I believe, therefore, that if the bones of Eocene mammals are not discovered in the lowest part of the Lignitic, they will be found in the upper strata. Moreover, the agglomeration of bones in certain localities depends on peculiar circumstances, and does not immediately and forcibly relate, like plants, to the general character of a whole period.

The land surface during the prevalence of the Lignitic formation was like that of the gulf shores at the present time. A belt of sand-downs served as a barrier to the sea, and extended inland, either barren or covered with pine-woods, and back of it there were mostly swamps—peat-bogs, rendered impenetrable by a luxuriant vegetation; everglades, like those of Florida, where animal life is limited to Saurians. A formation of the same kind is remarked all along the western coast of Africa, where, behind the sandy beach heaped by the ocean waves, extends a dark region of woody swamps, which even the inhabitants cannot penetrate—the abode of deadly fevers, of snakes and crocodiles, shunned by every kind of mammals.

The question of the subdivision of the Lignitic or Tertiary measures, which I have separated into four groups, from the non-coincidence in the general character of the flora, is still disputed, and this subdivision contradicted by the assertion that the discordances may be merely apparent, and a result of the geographical distribution of species, as we may see it now in groups

of plants at distant localities. The contemporaneity of the fossil floras is not merely marked by the identity of some species, but also by a kind of general character denoting the same climatic circumstances. The modification due to the geographical distribution may be easily recognized by the presence or absence of a number of species in the flora of the Bitter Creek Basin, of that of Colorado, the Raton Mountains, the Lower Union group, the Mississippi and Vancouver. There is between these localities a wide distance; and, indeed, the Vancouver flora may show, in its details, marked points of dissimilarity to that of the Mississippi. But one of the prominent characters of the Lower Lignitic is the predominance of Palms, and we find it manifest in all the localities named above. Indeed, I have found remains of Palm, especially *Sabal*, wherever I have seen Lower Lignitic strata; and, as it has been remarked already, *Sabalites Grayanus* has been observed on specimens from Vancouver, Point of Rocks, Golden, the Mississippi, etc. With this, there is, in all these floras, a predominance of subtropical forms and the absence of northern types, rendering more evident their correlation in time.

The series of plants of the second group has as yet no remains of palm-leaves, but fruits doubtfully referable to the Palm family. The general character of its flora does not indicate as high an average degree of temperature as that of the Lower Lignitic. According to Prof. Cope's statement, bones of Eocene vertebrate animals have been found in connection with it. Its true horizon may be rendered more definite by further discoveries. But, in the third group, the general character of the flora is evident, and its relation to the Miocene of Europe and of Greenland is defined, not only by this general kind of related facies, but also by a number of species, like *Platanus aceroides* and *Guillelmæ*, *Acer*, *Populus arctica*, *Taxodium dubium*, *Alnus Kefersteinii*, *Betula*, *Quercus*, *Corylus*, indicating, together with the total absence of Palms, a more marked difference in the climatic circumstances governing its flora and that of the first group. This difference, also, is not remarked at Carbon only. It is reproduced in the same degree by general affinity and identity of species in the flora of Coral Hollow, San Joachim County, and of Contra Costa, south of Mount Diablo, California; of Bridge Creek, John Day Valley, and of Blue Mountain, Oregon; of Bellingham Bay, of Alaska, as established by Heer's flora of that country, and therefore followed northward from Carbon to Greenland. Some of its types

are so definite that a single specimen of a species of *Acer* or *Platanus* would suffice to positively identify this group as Miocene, just as a few specimens of *Quercus furcinervis* proved the Eocene age of the Cascade Mountains of Oregon, whose formation was at first supposed to be post-Tertiary, or of recent origin.

We have seen also that the flora of the fourth group has a peculiar facies without distinct relation to that of the third. I regard it as Upper Miocene by affinity of some of its types to those of the same formation of Europe. A number of geologists, Dr. Hayden the first of them, have determined the position of the Green River group as above the lignite-bearing beds of the Rocky Mountains.

I do not consider, however, as definitive, the distinction of the geological divisions as they are established in this work and marked upon the table of distribution. New researches and discoveries may afford sufficient reasons for reversing my conclusions. They are only the expression of the testimony obtained from the determination of the vegetable remains examined until now. I have also acknowledged already that the groups of plants of the American Tertiary compared with those of Europe, representing different geological periods, do not demonstrate positive identification between the formations of both continents. I admit the lower group as Lower Eocene; the second group, which seems intermediate between this and the Carbon, may be Upper Eocene; the relation of the third group is by its plants with the Lower and Middle Miocene of Europe, and that of the fourth with the Upper. These are like the first outlines traced for the preparation of a map: they may be erased or modified; the spaces have to be filled as our acquaintance with the Tertiary becomes more intimate.

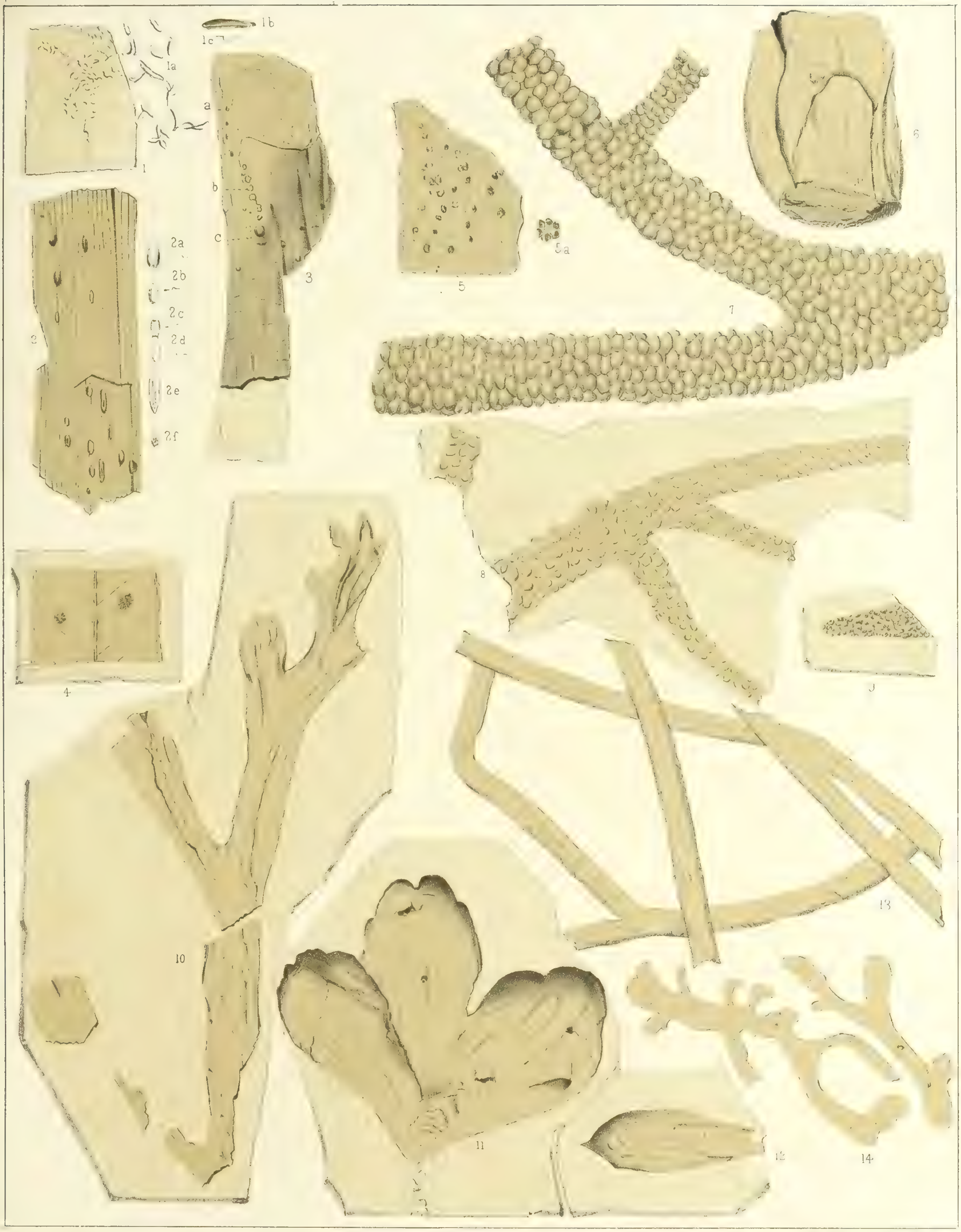
Now reviewing the whole question of the age of the Lignitic, I readily admit the fact, established from sufficient evidence by the researches of Profs. Cope and Meek, that a fossil Cretaceous fauna has left traces of its presence up to the very base of the Lower Lignitic measures, and that there the remains of a few invertebrate animals, and those of one Saurian, all of Cretaceous types, has been found, in connection with plants whose characters have been considered until now in Europe as representing a Tertiary Flora. Is the flora to decide the relation of age of the formation or the Saurian bones of Black Buttes, with the few shells of brackish water, either found there or which may be found hereafter in the same circumstances? The slow upheaval

of a new land at and from the base of the Lignitic is sufficiently evidenced, and has been recognized by every geologist who has explored the country. This land, which, rising up, is cut, of course, by shallow brackish swamps or estuaries, is the beginning of a whole formation of wide surface and great thickness, where the plants, preserving their Tertiary characters, have contributed the materials for the composition of the numerous coal strata, which constitute an essential part of it. In those brackish estuaries, paleontologists have already recognized species of positive Tertiary relation, mixed with a few remains of Cretaceous types. But these low swamps are drying up, their Cretaceous fauna is gradually reduced in its representatives by the influence of different atmospheric circumstances, while that of younger types becomes predominant. Henceforth the Cretaceous animals appropriate to deeper water may live still; their remains may even be found hereafter mixed with recent Tertiary strata, but their presence cannot modify the age of the new land formations. This admission would be against reason quite as much as the assertion that we are now still living in Cretaceous times, because animals of Cretaceous types are dredged from the depths of the ocean. For the determination of the epochs of the land formation, if we may call epochs arbitrary divisions of time established for convenience by geologists, we have to consider the documents relating to their history, and these are mostly the fossil remains of their floras.

INDEX OF GENERIC AND SPECIFIC NAMES.

NOTE.—Names of genera and species described are in Roman.

PLATE I.


1
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1b
1c
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2a
2b
2c
2d
2e
2f
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5a
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PLATE II.


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3
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PLATE III.


1a

PLATE IV.

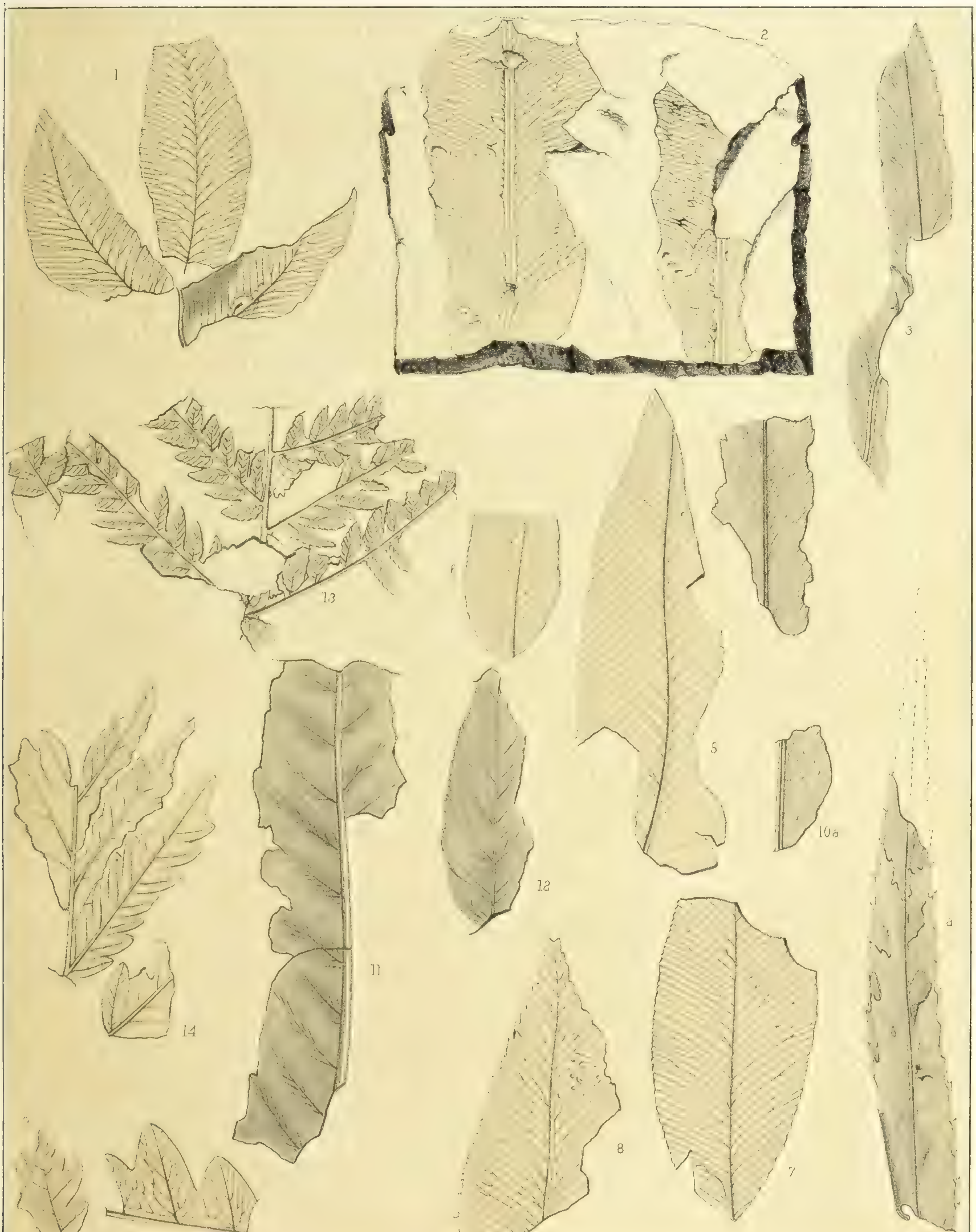

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PLATE V.


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12a
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13a
13b
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14b

PLATE VI.

PLATE VII.

PLATE VIII.

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PLATE IX.

Page.

FIGS. 1, 2. CYPERUS CHAVANENSIS, Gr. 2, 4 *a* 92

2 *a*. Fragment, magnified.

FIG. 3. CAREX BERTHOUDI, Gr. 1 92

3 *a* to 3 *d*. Seeds, magnified $\frac{2}{1}$ to $\frac{4}{1}$.

4. Fragments of leaves.

4 *a*. Same, magnified double.

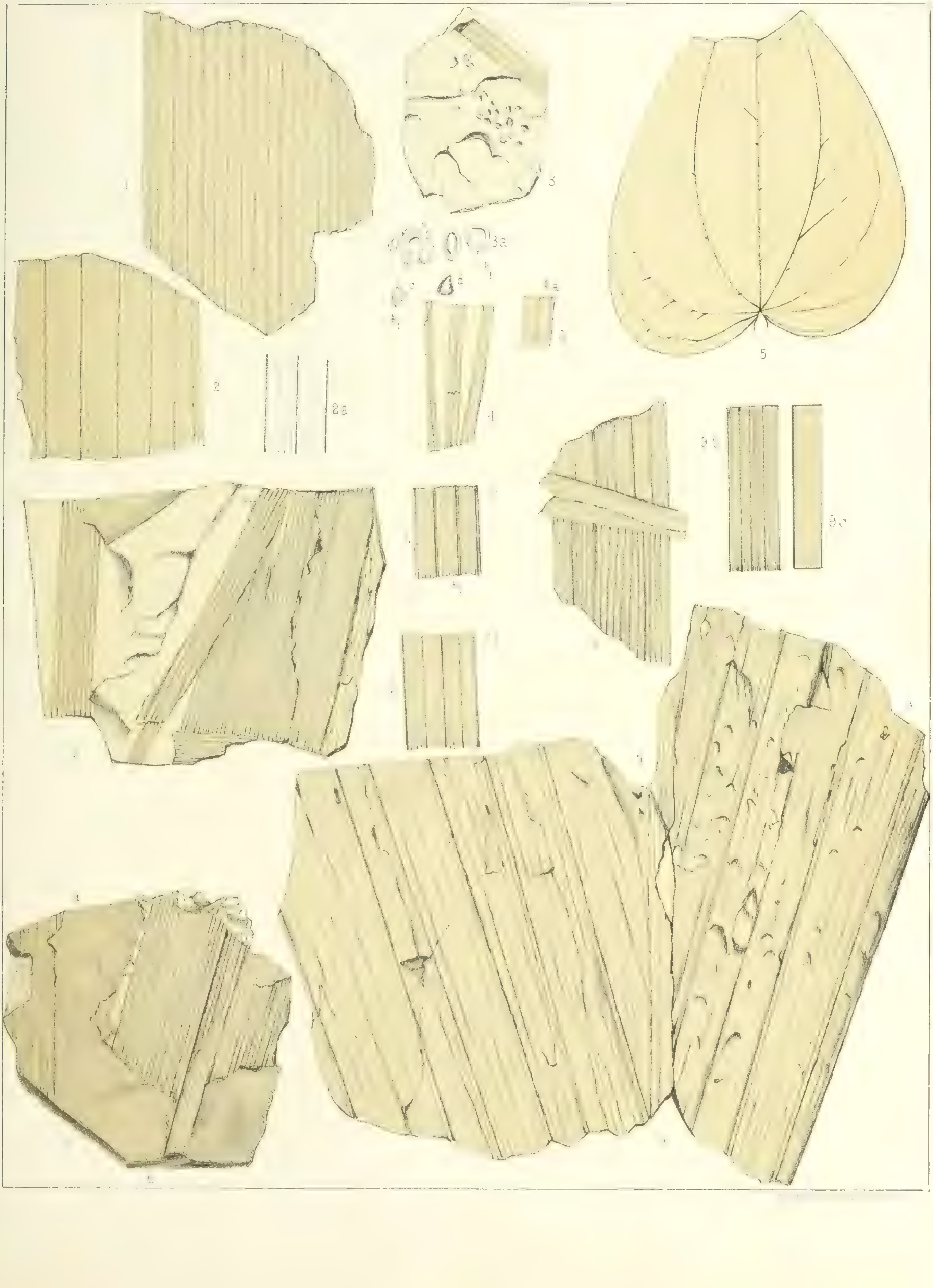
FIG. 5. SMILAX GRANDIFOLIA, Gr. 1, 3 94

FIGS. 6–8. FLABELLARIA ZINKENI, Gr. 1, 4 *a* 110

7 *c*, 7 *d*. Fragments of rays, magnified.

FIG. 9. GEONOMITES GOLDIANUS, Gr. 1 115

9 *b*, 9 *c*. Fragments of rays, magnified.


1
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2a
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9c

PLATE X.


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PLATE XI.

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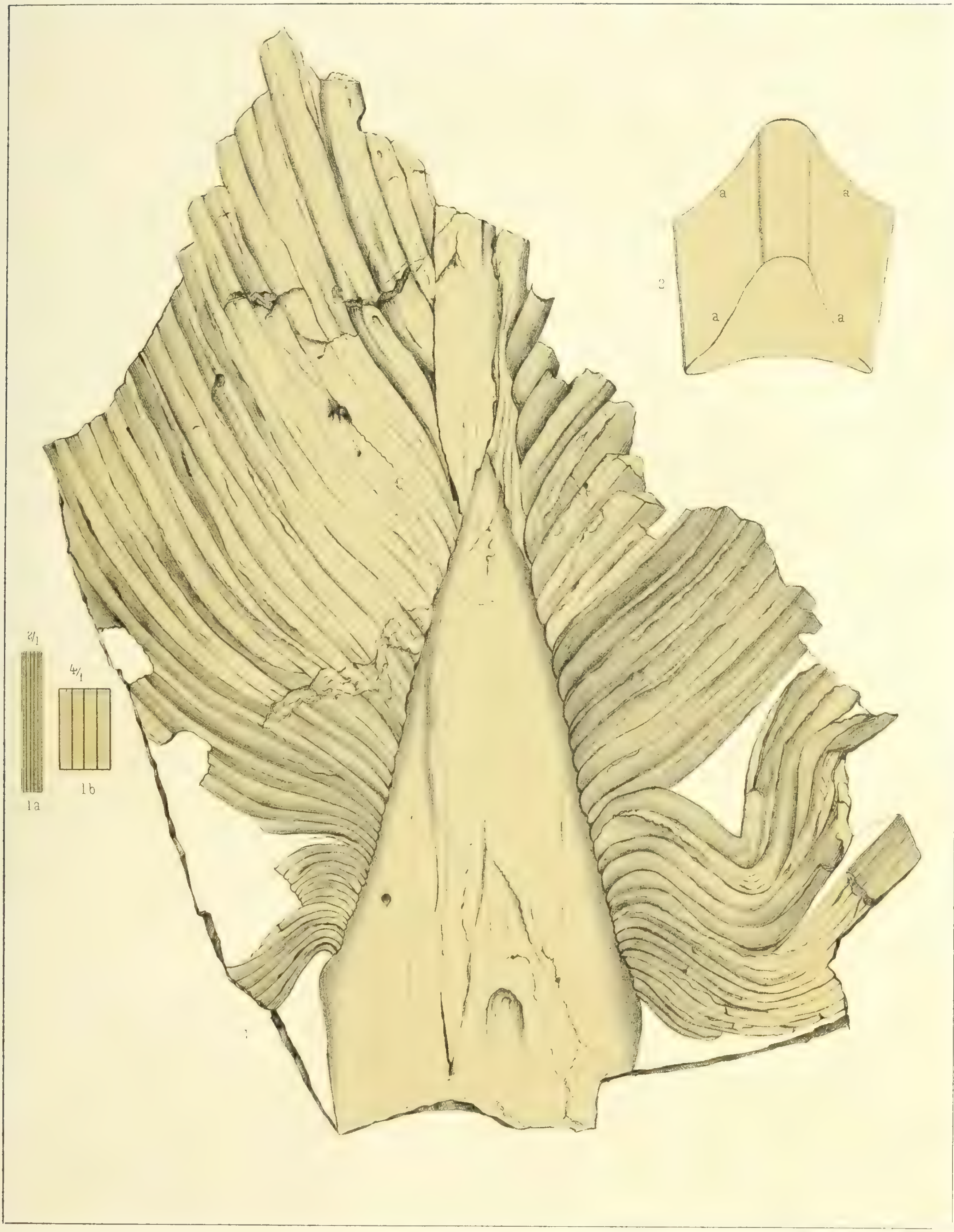
PLATE XII.


a
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2/1
4/1
1a
1b
1

PLATE XIII.

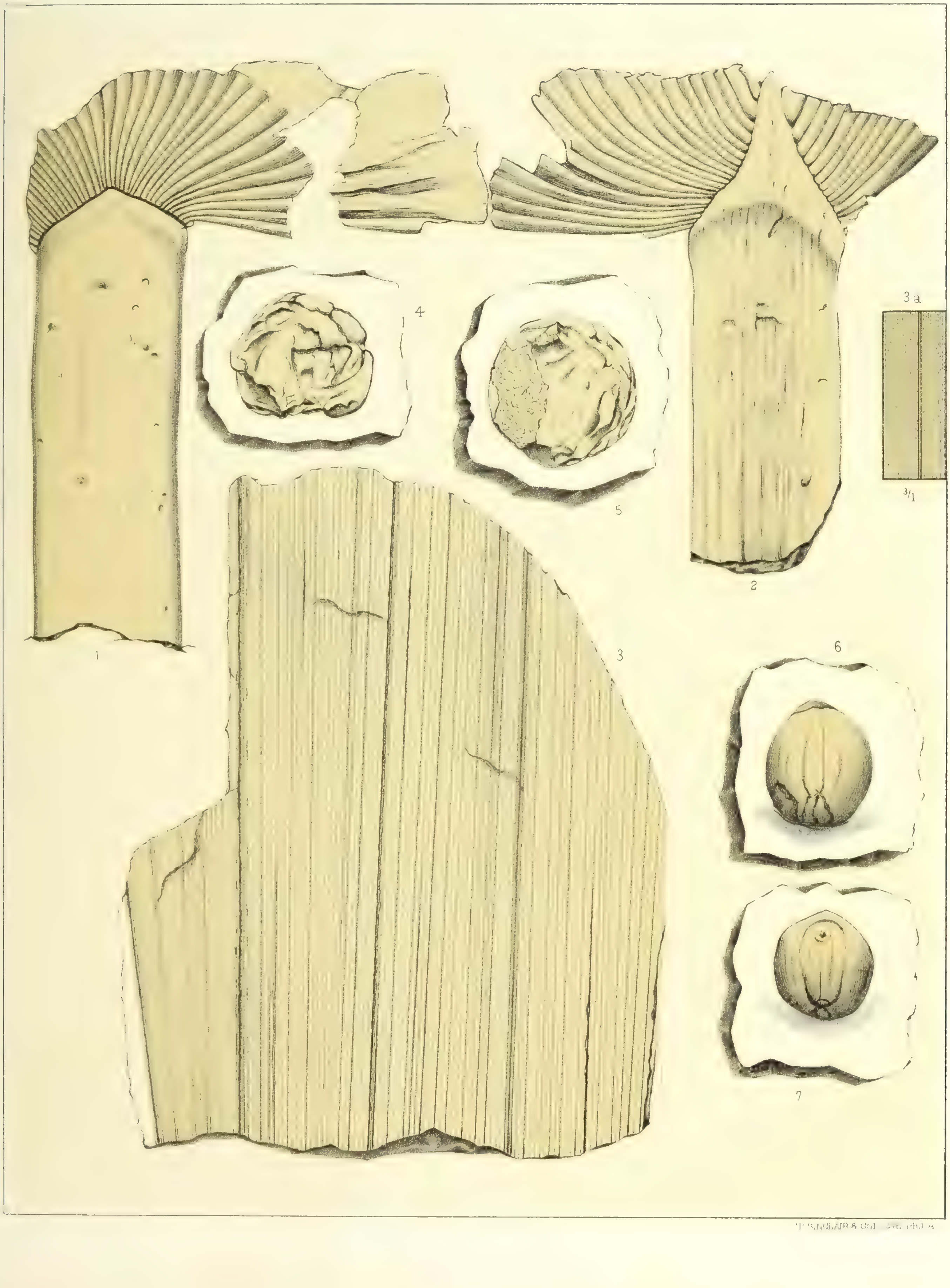

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PLATE XIV.

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PLATE XV.

	Page.
FIG. 1. MUSOPHYLLUM COMPLICATUM, leaf and midrib ?, Gr. 3	96
2. Fragment of leaf, with base.	
3. Large stem, with branches and leaves.	
4, 5. Point of leaves and lacerated fragment.	
6. Roots and rootlets.	


1
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3 a
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PLATE XVI.


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PLATE XVII.


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16 a
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PLATE XVIII.


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10a
11
a
a

PLATE XIX.

	Page.
FIGS. 1, 3. FAGUS FERONIÆ, Gr. 4 *b*	146
FIGS. 4, 5. QUERCUS NERIIFOLIA, Gr. 1, 4 *b*	150
FIGS. 6, 7. QUERCUS STRAMINEA, Gr. 1	151
FIG. 8. QUERCUS VALDENSIS, Gr. 3	153
FIG. 9. CARPINUS GRANDIS, Gr. 4 *b*	143
FIG. 10. QUERCUS HAYDENII, Gr. 3	157
FIGS. 11–13. QUERCUS ACRODON, Gr. 3	158
11 *a*. Fragment, magnified.	
FIG. 14. QUERCUS DRYMEJA, Gr. 4 *b*	157


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11a
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PLATE XX.

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PLATE XXI.

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PLATE XXII.

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PLATE XXIII.


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PLATE XXIV.

PLATE XXV.

FIG. 6. Stipule of PLATANUS HAYDENII ?, found at Golden, with leaves of this species.


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PLATE XXVI.


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PLATE XXVII.


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PLATE XXVIII.


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PLATE XXIX.


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PLATE XXX.

PLATE XXXI.

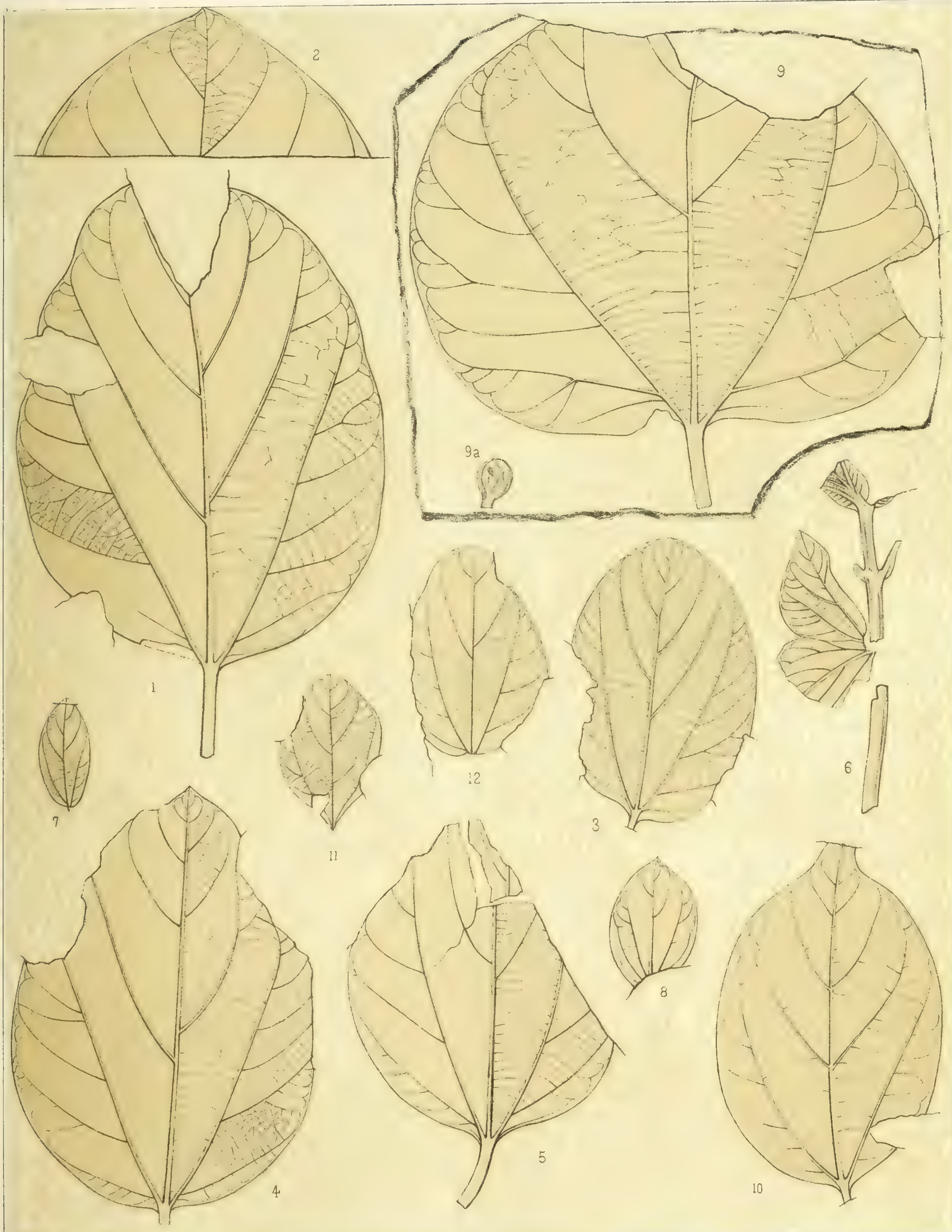
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PLATE XXXII.


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PLATE XXXIII.


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1a
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PLATE XXXIV.


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PLATE XXXV.


1a
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c
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b
c
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6a
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PLATE XXXVI.


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PLATE XXXVII.


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PLATE XXXVIII.


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PLATE XXXIX.


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PLATE XL.

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PLATE XLI.

PLATE XLII.

PLATE XLIII.


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PLATE XLIV.


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PLATE XLV.


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PLATE XLVI.


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PLATE XLVII.

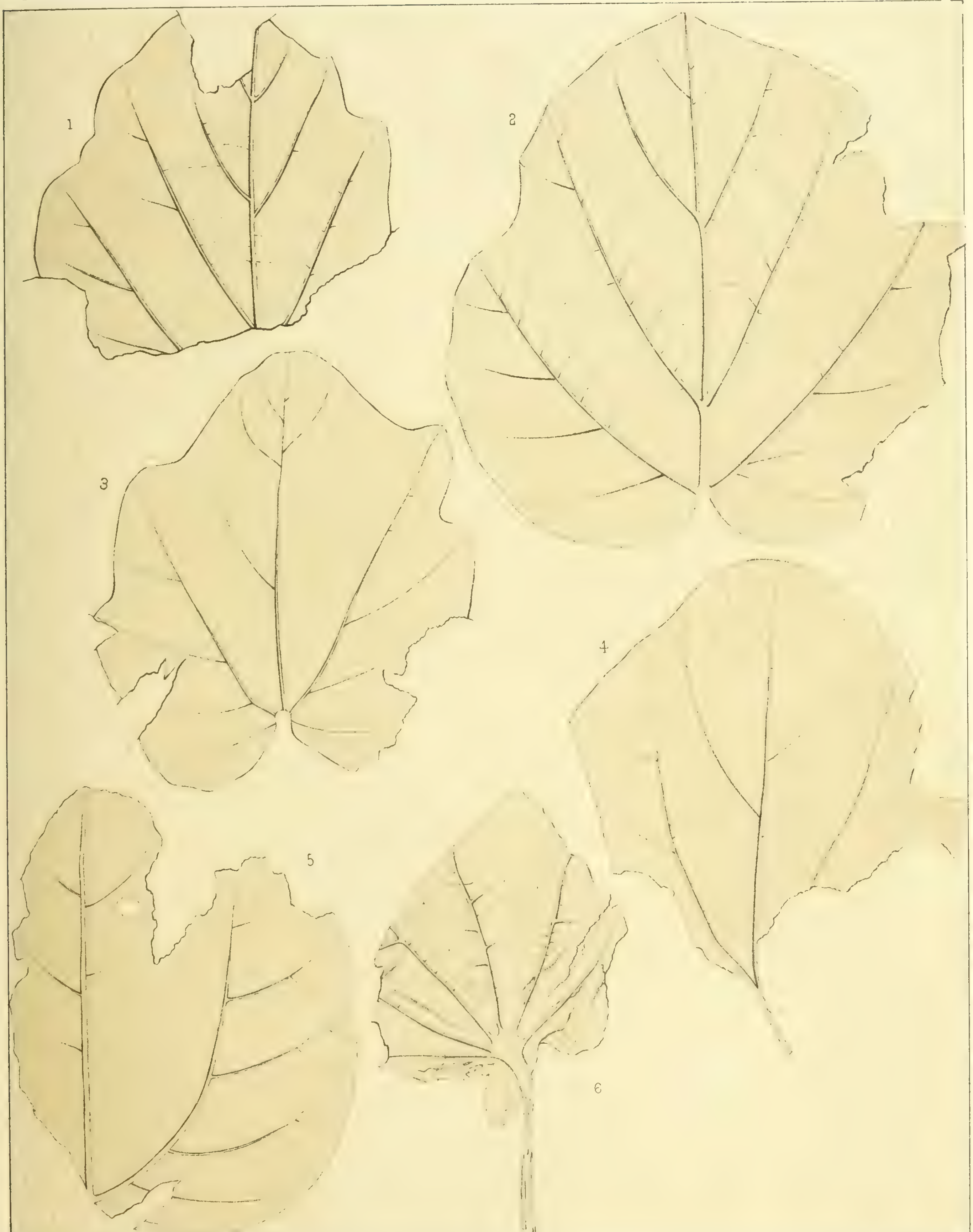
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PLATE XLVIII.


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PLATE XLIX.


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PLATE L.


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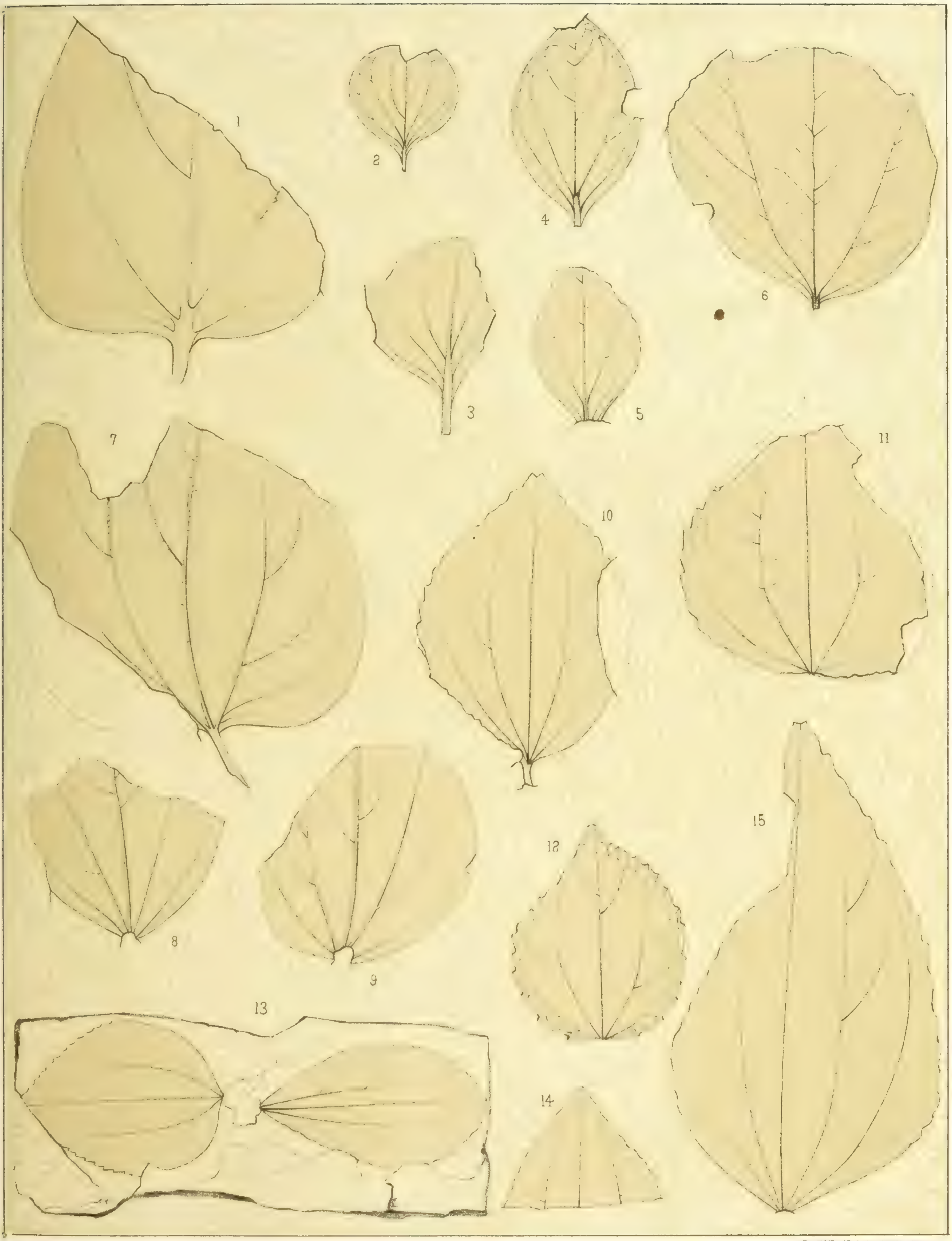
PLATE LI.



T. SINCLAIR & SON LITH PHILA

PLATE LII.

	Page.
FIGS. 1–6. ZIZYPHUS FIBRILLOSUS, Gr. 1	276
FIGS. 7, 8. ZIZYPHUS CINNAMOMOIDES, Gr. 4 *a*	277
FIGS. 9, 10. BERCHEMIA MULTINERVIS, Gr. 1	277
FIG. 11. RHAMNUS ALATERNOIDES, Gr. 1	278
11 *a*. Leaf, magnified.	
FIGS. 12–15. RHAMNUS RECTINERVIS, Gr. 1, 2, 3	279
FIG. 16. RHAMNUS INÆQUALIS, Gr. 1	279
FIG. 17. RHAMNUS ? DISCOLOR, Gr. 1	280


1
2
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PLATE LIII.


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PLATE LIV.


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PLATE LV.


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PLATE LVI.


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PLATE LVII.

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PLATE LVIII.


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PLATE LIX.


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9 a
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8 a
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14
a
d

PLATE LX.

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PLATE LXI.


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14a
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17a
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24a
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25a
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27a
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PLATE LXII.


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PLATE LXIII.

T. Sinclair & Son, lith. Phila.

PLATE LXIV.

PLATE LXV.


5a
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1a
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1
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14
15
7
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3a
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2
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13
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